

BOSTON
JULY 16 1861

24
4



Library
of the
University of Toronto

8/6

K/D

< 1862

Cat 6

Digitized by the Internet Archive
in 2018 with funding from
University of Toronto

<https://archive.org/details/hintsforformatio01unse>





AQUARIUM
with margin of Marsh Plant

W. DICKES

H I N T S

FOR

THE FORMATION

OF A

FRESH-WATER AQUARIUM.

PUBLISHED UNDER THE DIRECTION OF
THE COMMITTEE OF GENERAL LITERATURE AND EDUCATION,
APPOINTED BY THE SOCIETY FOR PROMOTING
CHRISTIAN KNOWLEDGE.

L O N D O N :

PRINTED FOR THE

SOCIETY FOR PROMOTING CHRISTIAN KNOWLEDGE;

SOLD AT THE DEPOSITORIES,

GREAT QUEEN STREET, LINCOLN'S INN FIELDS;

4, ROYAL EXCHANGE; 16, HANOVER STREET, HANOVER SQUARE;

AND BY ALL BOOKSELLERS.

LONDON:
PRINTED BY RICHARD CLAY,
BREAD STREET HILL.

LIST OF ILLUSTRATIONS.

AQUARIUM, with border of Marsh-plants	<i>Frontispiece.</i>
Aquarium, combined with Wardian Case	<i>page</i> 125
Adiantum Capillus Veneris	80
Anacharis Alsinastrum	51
Anagallis tenella	68
Argyroneta aquatica	107
Bartramia fontana	20
Batrachospermum moniliforme	16
Bleak	98
Bryum roseum	76
Caddis-worms	108
Callitrichie	57
Campanula hederacea	66
Carp	90
Centunculus minimus	69
Ceratophyllum demersum	42
Crayfish	102
Cyclas cornea	123
Dragon-fly	109
Drosera rotundifolia	63
Dytiscus marginalis	104
Elatine hexandra	71
Fontinalis antipyretica	18
— squamosa	19
Gudgeon	99
Hookeria lucens	21
Hottonia palustris	47
Hydrocharis Morsus-ranæ	44
Hydrocotyle vulgaris	74
Hydrophilus piceus	104
Hymenophyllum Tunbridgense	81
Hypnum ruscifolium	17

LIST OF ILLUSTRATIONS.

	PAGE
<i>Illecebrum verticillatum</i>	56
<i>Jungermannia excisa</i>	78
— <i>resupinata</i>	<i>ib.</i>
<i>Lemna minor</i>	58
<i>Limnæus auricularius</i>	121
— <i>palustris</i>	<i>ib.</i>
<i>Lissotriton punctatus</i>	86
<i>Loach</i>	100
<i>Lysimachia Nummularia</i>	75
<i>Miller's-thumb</i>	108
<i>Minnow</i>	98
<i>Mnium undulatum</i>	77
— <i>punctatum</i>	22
<i>Montia fontana</i>	71.
<i>Myriophyllum spicatum</i>	43
<i>Nitella flexilis</i>	55
<i>Paludina vivipara</i>	122
<i>Perch</i>	97
<i>Pinguicula Lusitanica</i>	65
<i>Planorbis corneus</i>	120
<i>Potamogeton densus</i>	41
<i>Prussian Carp</i>	87
<i>Radiola Millegrana</i>	70
<i>Ranunculus aquatilis</i>	37
<i>Scirpus Savii</i>	73
<i>Sibthorpia Europæa</i>	67
<i>Stickleback, three-spined</i>	91
—, ten-spined	92
<i>Stratiotes aloïdes</i>	50
<i>Subularia aquatica</i>	72
<i>Syphon</i>	114, 115, 116, 117
<i>Tadpoles</i>	84
<i>Tench</i>	89
<i>Utricularia vulgaris</i>	46
<i>Vallisneria spiralis</i>	52
— cell of	53
<i>Villarsia nymphæoïdes</i>	48
<i>Water-boatman</i>	105
— <i>scorpion</i>	<i>ib.</i>

HINTS FOR THE FORMATION
OF A
FRESH-WATER AQUARIUM.

TEN years ago the word AQUARIUM was of rare occurrence, and, in its classical limitation, was applied only to "a place where cattle are watered." It has now passed from the Latin to the English tongue, and has become literally a "household word," but with a meaning greatly modified. Custom has rendered such adaptations allowable. Indeed it not unfrequently happens that some instruction may be gained by watching the changes in meaning which words undergo during their transition from one tongue to another, especially if, in the interval, physical discoveries have made it necessary that they should be understood either in a restricted or an enlarged sense.

For example, at the period when the earth was considered to be a plane surface, extending further towards the east and west than it did towards the north and south, the term *longitudo* was with propriety used to denote the former measure, and

latitudo the latter. Modern discoveries have proved that the earth is a sphere; yet the words are retained with a meaning modified in accordance with the facts of the case. So, as we happen to have a very good English word, "watering-place," to express what the Romans meant by the word *aquarium*, there is no sufficient reason why we should not apply the latter word to something else, provided only that it be employed to denote *something containing water*. Let the water be salt or fresh; let the vessel which holds it be glass or stone, metal or wood; let cattle drink out of it or not; or, finally, let it contain, *besides* water, plants, or animals, or both; in any case there can be no serious objection to its being called an AQUARIUM.

But the AQUARIUM of which I am about to speak comprehends a more definite idea, and the meaning which I wish to have attached to it is this:—"An artificial reservoir of water stocked with living animals and growing plants assorted in such quantities and proportions that all shall equally flourish, and moreover so arranged that whoever will may watch their habits and growth with pleasure and profit." A mere vessel containing a few floating weeds and unhealthy fishes is not our object; we will be content with nothing less than an *Aquarium* such as we have defined it; and before we can satisfy ourselves, we must meet several important inquiries.

Of what material should the reservoir be composed ?

What animals should be selected and brought together with little probability of their injuring one another ?

By what rules can we determine the proportions which the animals should bear to the water ?

What plants should be selected, and how should they be apportioned ?

By what means are both plants and animals to be kept in a healthy state ?

Before proceeding any further, I ought to say at once that this little volume is intended to give rather suggestions of what may be tried, than rules as to what should be done. The taste for keeping aquaria has become very general of late, and many treatises have been published on the subject, some of which are of undoubted merit ; but all that I have seen are evidently written on the supposition that their readers are resident in London or in some large city. I do not mean to imply that they are objectionable on that account. On the contrary, it is to the inhabitants of large cities that the Wardian case and the aquarium are pre-eminently valuable. Dwellers in the country, who can at their pleasure resort to the society of ferns and mosses in rocky glens, hard by their own homes ; who can watch the green weeds waving and the spotted fish darting in the brook that

turns the village mill ; such will have ample opportunities of studying the works of God in Creation every time that they walk abroad. But the pent-up citizen, whose vocation requires an uninterrupted residence at or near the scene of his daily labours, and who must content himself with a single annual holiday, and that sufficiently brief, has no opportunity of forming a familiar acquaintance with Nature as she exists, robed with verdure and teeming with life. To him, therefore, beyond all others, any contrivance which will enable him to relieve the monotony of artificial life by the quiet contemplation of a mere scrap transplanted, as it were, into his own counting-house from the wide field of nature—to him, I say, a Wardian case, or an aquarium, is pre-eminently an intellectual amusement, and a refreshment of priceless value. Much gratitude is due, therefore, to those naturalists who have devoted themselves to the study of the conditions on which Nature would condescend to take up her abode within brick walls, in a murky atmosphere, and amidst the odours of commerce. But for such I have said I do not write. They will find in Ward's delightful volume on "The Growth of Plants in closely glazed Cases,"* and in Lankester's "Aqua-vivarium,"† all that they can desire ; the principles on which they are to act, and what they are to do, and how to set about it.

* Van Voorst.

† Hardwick.

It may not appear at first sight in what material respect instructions to persons residing in the country can differ from those intended for the use of townsfolk, inasmuch as animals and plants equally consent or refuse to accommodate their habits to the tastes of their admirers, whether dwelling in town or country. The explanation is this :—in large cities, no sooner does a demand arise for any saleable article than it is met by a supply. A taste for aquaria has rapidly sprung up, and forthwith a new trade has followed it. Some persons for the sake of profit, (and a very legitimate one it is,) others, discovering the means of pursuing their taste for natural history, and at the same time securing to themselves an equivalent for their lost time, opened dépôts of all that was necessary to stock an aquarium ; and to draw custom to their own stores, compiled and published books of practical directions, all of which are, to a certain extent, to be depended on. Acting on the instructions contained in some of these, any one desirous of having an aquarium may provide himself with a vessel suited to the state of his finances ; he may even purchase gravel, sand, plants, fishes, shells, and insects ; and having thus set himself up, may find his aquarium in full work at the expiration of two or three days, or even less. In short, to start an aquarium in London, and probably most other large cities—I do not

say to keep one in a healthy condition—is no more beset with difficulties than the making of a plum-pudding. For example :—

Recipe.

In any convenient vessel place one pennyworth of well-washed river sand ; over this lay two pennyworth of silver sand, also well washed. Pour gently over the whole about a pint of Thames water (not previously boiled), and plant about two handfuls of such aquatic weeds as the dealer has on sale, and fill the vessel to within two inches of the top with water. When the whole has stood long enough, add about a dozen small fish, and as many water snails. Feed with red worms and bread crumbs.

In the country, prolific though it be in water, weeds, and fish, these directions would be absurd. The weeds have to be selected, the fish caught, and the water snails brought to land. The London dealers, guided by their own experience, and the information which naturalists are always ready to give to any one consulting them, are provided with an assortment of the most desirable kinds, and of a convenient size ; but here in the country, surrounded as we are by rivers, canals, and ponds, the very abundance of what we want distracts us. Those water-lilies are too large ; these sedges are

too tall ; while yonder tangled mass of slimy weed which affords shelter to newts and tadpoles can under no circumstances be attractive. Not quite so fast ; it is this slimy weed which is to furnish us with some of our most interesting specimens. But let us proceed warily, and step by step ; for if we plunge headlong into an aquarium on this extended scale, we may chance to be more than disappointed. Let us proceed, then, *seriatim*. Bearing in mind our definition of an aquarium, we will first inquire what description of reservoir will be at the same time simple, cheap, and easily procured. These conditions I consider essential, because an aquarium should not simply be an amusing toy for the rich, but a means of conveying important instruction to all classes. To the young especially it may be made profitable in the highest degree. Familiarity with the elegant forms of the weeds and graceful movements of the fish must tend to refine the tastes of children. The experimental process of discovering the right proportion of plants and animals, so that each may promote the well-being of the other, will afford a fruitful field for illustrating the all-wise and unfailing providence of GOD, who, without effort, preserves throughout the universe the wonderfully harmonious arrangement of nature by the perfect application of rules which He permits, nay, commands us to explore, and which we are here, on a small

scale, endeavouring to apply. Even the uncouth water snails, the scavengers of the collection, may be made an apt vehicle for conveying the lesson, so important to the young, that none of God's creatures are too vile to be beneath his notice, or to be exempt from their several duties; while the very brightest of the finny tribe, though it glitter with gold and silver spangles, is less near and dear to its Maker than are to Christ the souls of his little ones. Religious instruction thus imparted to the child, whose interest is enlisted by real subjects of sense, and whose joyousness is not checked by the formality of a lesson conned from a book, can scarcely fail to make a deep and lasting impression. And while this heavenly seed is sown, it may happen, too, that there may be implanted a taste for the study of nature which will take root; and in the form of botany, or zoology, or physics, give healthful occupation hereafter to hours which might otherwise have been devoted to idleness and its companion, sin. "Consider the lilies how they grow." (Matt. vi. 28.) "Speak to the earth and it shall teach thee." (Job xii. 8.)

It is a bitter source of complaint among the clergy, that while the wealthy and educated classes of society come regularly enough to church, and are devout in their deportment while there, the ignorant poor in many of the agricultural districts can hardly be prevailed on to come at all,

unless the prospect of some temporal advantage be held out to them, and that while there they take no part in the devotional service, and are listless and asleep during the sermon. Now, do these two assertions stand to each other in the order of cause and effect? Are the poor irregular in their attendance at church because when there they are not interested in what is going on? or is their very irregularity the cause of their listlessness? I believe the former supposition to be, in most cases, the correct one. Having a very limited acquaintance with the meaning of words, they have great difficulty in understanding an illustration of the simplest kind, and are utterly unable to comprehend an argumentative discourse of any sort. But suppose them to have been accustomed from their earliest years to brief and impressive discourses on the wisdom, power, and goodness of God, in creating, preserving, and sustaining the various objects in the material world which they see around them; suppose their teacher to have taken them, while they were yet the lambs of the fold, abroad into the fields, and to have illustrated his teaching by reference to the grass, the flowers, the trees, the flocks, the birds, the clouds, the fruitful ears of corn, and the barren—all subjects on which the Great Shepherd of the sheep founded his discourses—might not the result have been different, and the head which is now buried between

the hands in deep slumber be bowed in awful reverence of the God by whose providence its very hairs are numbered? He must be a bold man who would venture to assert that the example is one which it would be either unsafe or unwise to follow.

Now, what the grass, the flowers, and the other objects which I have named are in the fields, the aquarium is in the nursery or the schoolroom; and on this account I should be glad to see one in every national schoolroom throughout the country, and in every family where there is sufficient intelligence to keep it at work, and sufficient knowledge to make it tell its tale aright. In order that this may be the case, it must be inexpensive. And here we should seem to be met by a serious difficulty. The most appropriate kind of vessel for the purpose is a box, three of the sides of which at least are of glass; and this is a costly article, even when provided in the most economical way. We dismiss, then, the best form of aquarium as being too expensive to be within the reach of those in whose hands we are most anxious to place it. Another and a less desirable form is that of a glass globe, such as those in which gold fish are often kept, or that of an open bell-shaped vase. Gardeners are in the habit of using for the protection of tender plants, and cuttings in process of striking, bell-shaped glasses, which, though of coarse mate-

rial, are sufficiently even and transparent to allow objects to be seen through them with tolerable distinctness. They are called propagating glasses, and may be purchased at a trifling cost in most towns, at shops where articles made of blown glass are exposed for sale. The largest size in common use measures fifteen inches in diameter, and sells for two shillings and sixpence; the next size, twelve inches, costs two shillings. Of the two, the first is far preferable to the second, as the quantity of water which it will hold more than the other is much greater than the difference of price would lead one to expect. The reason why the rectangular vessel is preferable to the globular or bell-shaped is, that objects seen through a plane surface of glass appear as they really are, because the rays of light which proceed from them to the eye of the spectator are not bent or refracted in their passage; but when the sides of the vessel are circular, the rays are refracted during their transit to the eye, and the objects are magnified and distorted. Moreover, one may see quite through a rectangular vessel, and so obtain a good view of all the contents of the aquarium without materially shifting one's position; but in the others one can only see what lies on the nearest side, and such objects as are in proximity with an imaginary line drawn from the spectator's eye through the centre of the aquarium. The living tenants will thrive

equally well no matter what be the shape of their dwelling. As this is the case, and as we can look *down* and see the contents of the vessel equally well whether it be round or square, rather than be foiled at the outset by the expense of the more desirable form, we must even make the best of that which we can afford to buy.

Having provided ourselves with a vessel to contain our treasures, our next step is to fix it in an inverted position. The propagating glass is furnished with a knob to serve as a handle. If you are skilled in the use of the turning-lathe, you will have no difficulty in shaping a disc of wood so as to be flat beneath, and hollowed above into the form of the base of the glass. In some shops such stands can be purchased ready made, either in wood or earthenware, but they are not indispensable; a common garden flower-pot will answer the purpose very well. This should not be less than six or eight inches in diameter, for one of less size would scarcely stand steadily. Fill it (heaped measure) with any finely-sifted earth, and having inserted the glass in the centre, press it down, taking great care, however, that the glass shall not touch the rim of the pot, but that the two are separated by the overflowing earth. The objection has been made to the use of the propagating glass for this purpose, that it is liable to be fractured by a heavy step near it, or even by a loud noise.

This, I think, is not likely to occur if there be a padding of earth, as it were, all round, which will prevent vibration. The whole should now be set where it is destined to remain, because when filled with water it is too ponderous to be lifted with safety. Its position should be low, in order that those for whose amusement, or I should say instruction, it is intended, may be able to inspect its contents from above. Another advantage attendant on this arrangement is that, thus placed, the rudeness of the stand will be out of sight. But seen or not, if the aquarium be nicely stocked, and in a healthy condition, no one will think of looking away from the plants and animals in order to detect flaws in the stand. One thing is indispensable, that it should be placed where it can get plenty of light, and if the sun shine on it for a portion of every day, so much the better. The reason of this will be explained hereafter.

A rectangular vessel should be placed higher, or the advantage which it possesses of offering a better view when looked through cannot be appreciated.

We will now suppose the dwelling provided; it remains that we should put it into a fit state to receive the expected guests. Aquatic plants in general are nourished, principally if not exclusively, on food which they derive from the water, and therefore do not require soil; yet if thrown into

the aquarium indiscriminately, they will either rise to the surface, or float about half suspended in the water, as often as not with their roots uppermost ; and, if they endeavour to recover their natural position, they are liable to be displaced whenever fresh water is added. But the beauty as well as the thriving condition of the aquarium depends as much upon the plants as the animals ; and I should not hesitate to call the experiment a failure if the vessel contained ever so many healthy *animals* without a fair proportion of growing plants. If only two or three sorts of aquatic weeds can be found in a neighbourhood which will attain perfection in a domesticated state, let them be chosen to the exclusion of all others. But every effort should be made to cultivate them in such a way that the aquarium would be an interesting and a beautiful object even if animals were omitted. Whether the vessel employed, then, be a tank or a bell-glass, make it perfect as a water-herbarium first, and then stock it with animals. I do not recommend that soil of any kind should be used. Fish vary greatly in their moods, and at certain times will choose to lie near the bottom of the water ; in which case every movement that they make will throw up the lighter particles, and render the water so turbid that nothing can be seen to advantage. Begin, then, by collecting either from the surface of a garden, or from a road-side after

heavy rain, or from a running stream, enough gravel to cover the bottom of the glass to the depth of two or three inches, until we may say the surface is on a level with the spring of the dome. The gravel should be previously washed until water runs from it unsullied. Whether the water weeds should all be planted in the centre, and a space thus left for the fish to swim round, or whether they should be planted here and there all over the bottom, is a matter of taste. In any case their roots should be buried in the gravel, or, if need be, moored fast by being tied with bast mat to a tolerably heavy stone. This material is recommended for tying as being inconspicuous, and not liable to shrink when wetted, and so to cut the stems round which it is fastened. Nothing is now absolutely required but a supply of water. A level surface of gravel, however, is by no means attractive; and as it is quite possible to introduce some variety without doing any violence to nature, we must look for something more. Arches and caverns are fantastic; corals, minerals, and sea shells are altogether out of place; but objects are within reach open to neither of these objections, and vying in elegance with the most beautiful forms in nature. Go to some trout-stream which runs over a rocky or gravelly bed, and you will see, waving to and fro with every motion of the water, tufts of some light substance, varying in hue from light green to dark

green, brown, and black. Separate a portion of this substance from the rock to which it adheres : it lies in the hand a lump of tangled threads or quivering jelly,—unpleasant to the touch, perhaps, and unsightly to the eyes. Place it, however, in a tumbler of clear water, and the tangled threads unravel and spread out in a most beautiful, feather-like form, while the shapeless jelly, no longer a sluggish mass, assumes the form of a branched



BATRYCHOSPERMUM MONILIFORME.

necklace, earnestly inviting, if you are the happy possessor of a microscope, instant examination. I do not know whether it would be feasible to transplant these plants from the rocks to your aquarium, but this is unnecessary. By dint of a little search, you will not fail to find some specimens attached to stones, which you can remove from their bed in the river, and carry home to form a rocky bottom for the aquarium. There are also three kinds of aquatic moss which, if you can find them in your

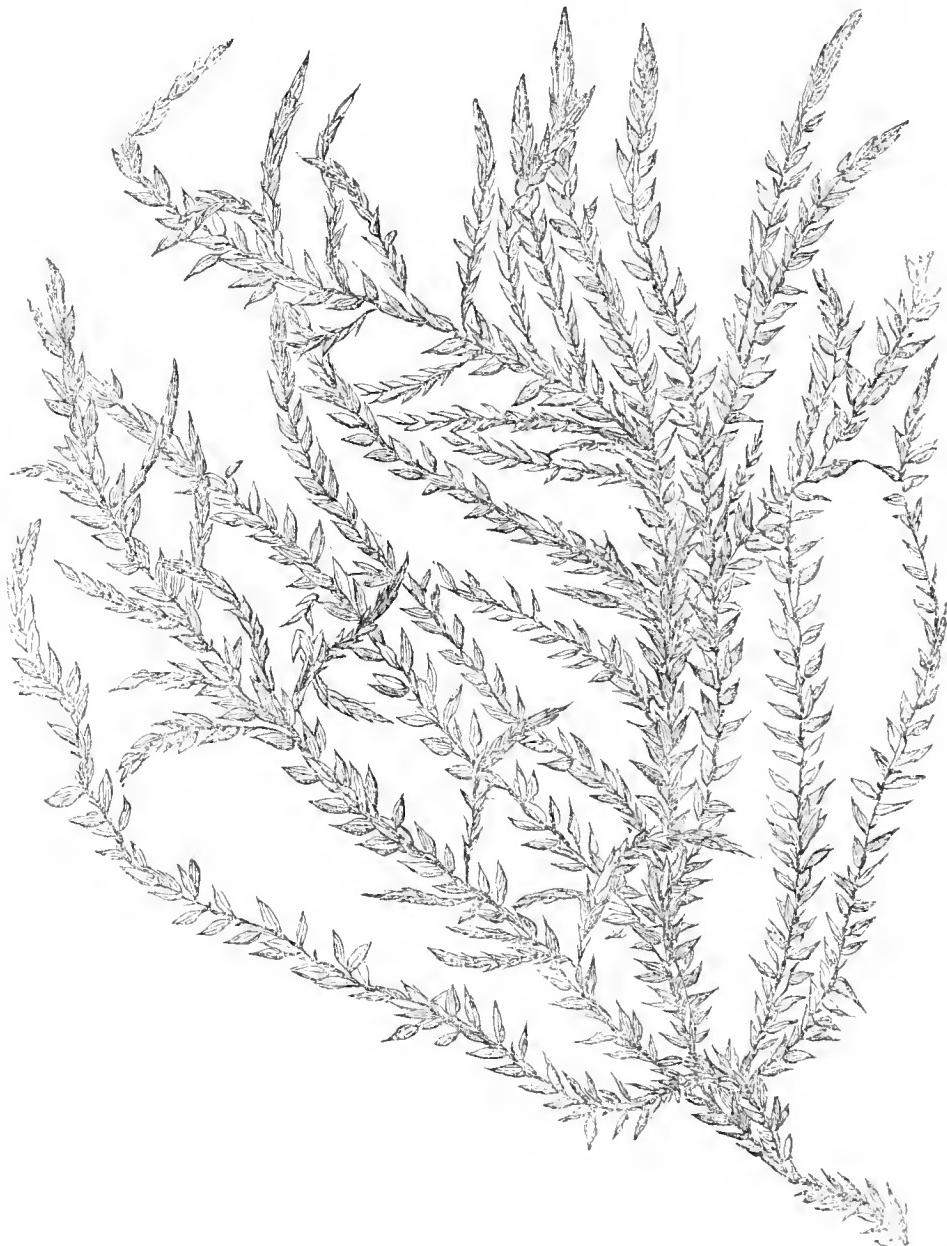
neighbourhood, will prove highly ornamental. The first, *Hypnum ruscifolium*, grows in rivers, wells, and on the stones of dripping springs. It has



HYPNUM RUSCIFOLIUM.

branched stems, rather large leaves of an olive brown hue, and a curved seed-vessel seated at the extremity of a long stalk. The second, *Fontinalis antipyretica*, grows in similar places ; its stems are of a less wiry texture than the last ; it grows in a more pyramidal form, and its leaves, which are of a bright green hue, and among the largest of

British mosses, are conduplicate; that is, folded together in halves. The third species, *Fontinalis*



FONTINALIS ANTIPYRETICA.

squamosa, is most abundant in mountain streams, to which, by forming masses of rich olive brown, it

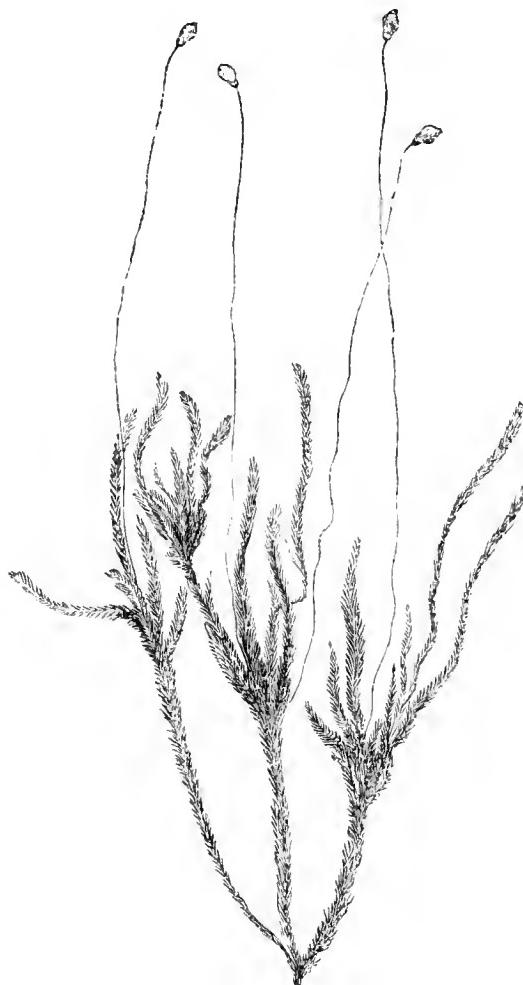
imparts one of their most characteristic features. Either, or all of these, if they can be found attached



FONTINALIS SQUAMOSA.

to moderately sized stones, may be enlisted into the service of the aquarium with striking effect.

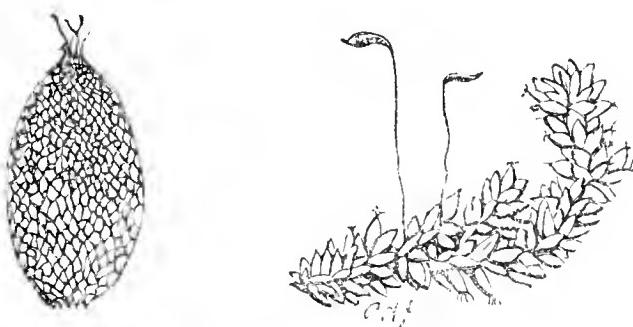
Fortunately for us, our aquarium does not resemble a flower-bed in a garden, which, when once stocked for the summer, must remain much in the same condition until the season for transplanting comes round again. Our nurslings are tenants



BARTRAMIA FONTANA.

at will; we can keep them as long as they answer our purpose, and unscrupulously eject them when the tenement is required for some new occupant.

Accordingly, if any one of our plants is impatient of confinement, or shows by its unhealthy condition that our treatment does not agree with its constitution, we can discard it at once, and endeavour to find some more tractable subject for our care. We may try, for instance, if some of the half aquatic mosses, such as *Bartramia fontana*, which forms such beautiful bright green cushions in dropping springs, may not be induced to flourish with us, if but for a time. Or we might contrive

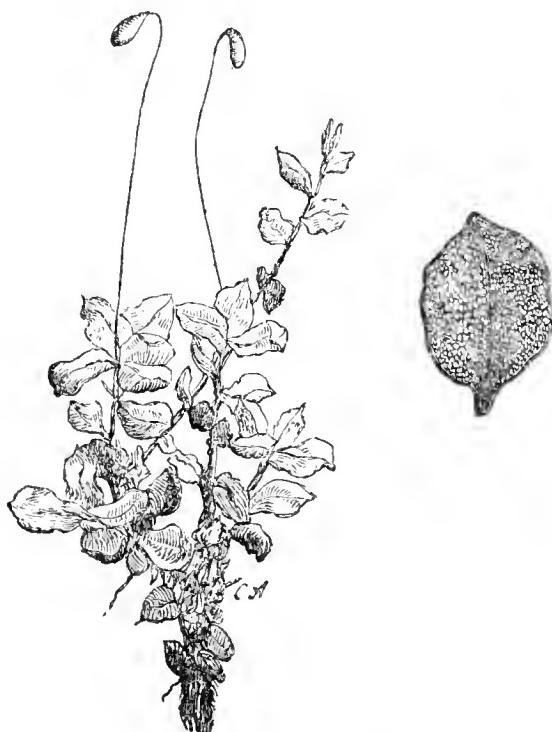


HOOKERIA LUCENS.

a home for *Hookeria lucens*, or *Mnium punctatum*, the leaves of either of which would afford us at any time a fresh specimen of the most exquisite forms of cellular structure. These we shall not fail to find in the dark holes which the water-rat has hollowed out by the side of alder-lined streams. It does not occur to us at once how we are to imitate their natural condition of growth, but experience may teach us; and even if we fail, we shall have practised patience and learned humility.

The solid structure of the aquarium being thus

completed, it remains for us to fill it with water. This we must do, gently at first, for fear of displacing the plants, by help of a garden watering-pot provided with a rose; but when all is covered



MIMULUS PUNCTATUM.

to the depth of a few inches, less precaution is necessary. We must be careful, too, as to what water we use. Spring water is objectionable, as it may be impregnated with lime, iron, or other mineral substances prejudicial to animal life. Again, an instance fell within my own notice, of water being employed which was pumped from an underground cistern or reservoir of rain-water; the result was, that in twenty-four hours,

every fish was dead. I have used rain-water dipped up from an open cistern, which answered perfectly well. The water of any river, probably, will do as well, provided that it be not taken just below a manufactory in which chloride of lime or other poisonous substance is largely employed. The fact that there are actually fish living in the stream, is not to be considered conclusive evidence that it is fit for an aquarium ; for, though alive, they may be sickly, or they may have been gradually inured to strong doses of the poison. Moreover, the power of resisting the effects of certain poisons varies considerably in different fish ; all the trout in a stream, for instance, being sometimes killed by lime, while other kinds of fish appear little, if at all, affected. Should any doubt exist, the wisest plan will be to try the effect of the water on fish placed in a separate vessel, before the aquarium is started.

Before we proceed any further, we will inquire, in order that we may have before us a clear idea of what we propose to do, on what principle we are about to assemble in the same vessel creatures belonging to the two great classes of organized beings ; and this inquiry we will premise by another : Would it not be better to have two separate vessels, one for animals, the other for vegetables, so that they may have each ample room to develop

themselves? Or is there a positive advantage attendant on this union of the two classes? This question we will proceed to consider.

When the aquarium has been allowed to stand long enough for the water to recover its transparency, and has had the sun shining on it for a few hours, we shall discover that the plants which are attached to the stones, and have never ceased to grow, and probably some of the others, have undergone a slight alteration in their appearance. Minute globules, brilliant as beads of quicksilver, may be seen clinging to the edges and points of the leaves, as if the spray were loaded with metallic fruit. Suddenly one of the largest detaches itself from a plant, rises rapidly to the surface, floats for a second in the form of a bubble, and disappears. The rising of that particle is the key to a law of nature as important, if properly employed, as the falling of Newton's apple became (after it had been duly worked out in the laboratory of the philosopher's mind), in solving the laws of gravitation. The one led to the discovery of the law which regulates the movements of the earth and its companion planets; the other may help to give us an insight into another Divine law, in accordance with which the Beneficent Creator clothed the earth with grass and herbs, and gave them as food to living things innumerable. Let us approach the subject with reverence, and we cannot fail to

be struck with admiration of the simple arrangement by which this important work is carried out, yet which, simple as it is, lay hidden from the investigation of man for little less than six thousand years.

The atmosphere, or spherical body of air in which the earth is enveloped, though variable in density, is everywhere found to be constituted alike, its component parts being three invisible gases, of which two, nitrogen and oxygen, are combined in the ratio of eight to two, with a slight admixture of a third gas, carbonic acid. To make this quite clear: a room ten feet high, and measuring twenty feet long by ten broad, contains 2,000 cubic feet of air. If this air were separated into its constituent parts, the result would be 1,600 cubic feet of nitrogen nearly, 400 of oxygen nearly, and one cubic foot of carbonic acid gas. Such is the nature of every breath of air we inhale. Not such, however, is that which we exhale. An analysis of this would show that a portion of the oxygen had disappeared, and that its place had been supplied by carbonic acid. It is evident, then, that some change must have been wrought on it in the lungs. What is that change, and whence comes the increased quantity of carbonic acid? This gas, it has been discovered, is not a simple substance, but consists of oxygen gas and a substance called carbon, the two being che-

mically combined in the proportion of about eight to three. Carbon in its solid form is the main constituent of all kinds of food, especially bread and all fatty substances. These, in the process of digestion, are taken up by the vessels of the stomach, and, in the course of the circulation of the blood, are exposed in the lungs to the action of the air as it is taken in at every inspiration. Here, by some chemical elaboration which it is beyond the power of man either to explain or to imitate, a certain portion of the carbon contained in the blood unites with the inhaled oxygen, and is respired in the form of carbonic acid gas. Oxygen, then, is essential to animal life. What office is performed by nitrogen is unknown ; probably, its principal office is to dilute the oxygen ; but it is certain that it will not alone support animal life, while carbonic acid proves instantaneously fatal. The combination of carbon with oxygen to form carbonic acid in the animal frame is always accompanied by increased temperature ; and every one knows that the accelerated circulation of the blood consequent on violent exercise is always attended by rapid breathing and increased heat. When we light a candle, we place the carbon of the fuel under such conditions that it combines rapidly with the oxygen of the air ; the result is heat and an abundant formation of carbonic acid gas. The same gas is also generated by all

substances when undergoing the process of fermentation, and hence the fearful instances of death caused by persons descending incautiously into a brewer's vat. Large quantities of carbonic acid gas are also given off during the decay of all animal and vegetable substances, thus vitiating the atmosphere in two ways; first, by robbing it of its oxygen, and, secondly, by pouring forth its own poison. Now, if every living thing that breathes, every fire that burns, and every atom of organized matter that decays, thus combine to render the atmosphere unfit to support animal life, and if this process has been going on, of which there can be no doubt, since the creation, it is evident that there must be some counter-acting influence at work, poised on the unerring balance of Omnipotence, to prevent confusion, disorder, and death from creeping into the universe, and marring all, before the time which Divine Providence has ordained.

Such a little silver bubble as we have seen rise from the vile* pond-weed, was the first messenger that heralded the discovery of what this counter-acting influence was. The sketch which I have drawn of the mode in which animal life is supported by the consumption of air, brief and imperfect as my prescribed limits have compelled me to make it, will nevertheless enable me to dismiss

* *Projecta vilior algâ.*

the remainder of this subject in a few words. As animals inhale from the atmosphere oxygen, and, having combined it with the carbon of their substance, respire it in the form of carbonic acid gas; so growing vegetables, by a reflex process, inhale or absorb carbonic acid gas. This they decompose, retaining the carbon, and converting it first into sap, and finally into vegetable tissue. The silvery bubble was a globule of pure oxygen, elaborated by the humble yet exquisitely perfect machinery of a weed, and sent forth by the fiat of Omnipotence along with myriads of its companions, all commissioned to restore to the atmosphere a supply of vital air sufficient to compensate for that abstracted by living and breathing animals.

And now we are in a position to render a satisfactory answer to the question proposed a few pages back: "Would it not be better to have two separate vessels, one for animals, and one for vegetables?" Decidedly not. No animals can live for any length of time in the same body of water, unless there exist some means of restoring to it the oxygen consumed by their respiration. Warm-blooded animals—a class which, we have seen, owe their very warmth to the quantity of oxygen they consume—cannot remain for a long time submersed in water of any kind, because no water contains enough to satisfy their requirements. They are obliged to come frequently to

the surface for a fresh supply. Such is the case with the whale, the seal, and the porpoise. Fish are termed cold-blooded animals, because the temperature of their bodies, though above that of the medium in which they swim, is considerably below that of quadrupeds, &c. The bulk of aëriform oxygen contained in water being immeasurably below that of the atmosphere, the quantity which they inhale is proportionally small; but if they are placed in water which has been entirely deprived of its oxygen by artificial means, such as by an air pump or by boiling, they invariably perish. To them the gills answer the same purpose that lungs do to warm-blooded animals. Water enters through their mouths, and passing through the gills, which are minutely subdivided, in order to present as large a surface as possible to the life-giving fluid, there oxidizes the blood, and goes out by the aperture behind. If this process be repeated continuously for any considerable length of time (varying in different species), the oxygen becomes so reduced in quantity that the circulation is impeded, and finally arrested, and they are *drowned* or suffocated in their own element. Just so, a man who falls into the sea loses his life, not on account of any noxious effects of the water on his system, but because no fluid is presented to his lungs containing enough oxygen to aërate his blood;

that is, to combine with carbon, and form carbonic acid gas. The man may be resuscitated, if life is not quite extinct, by restoring him to a medium fit for him to breathe; and a half-drowned fish may be restored, by pouring fresh water on it. Fish, consequently, that are kept in a vessel containing water only, require that the water should be frequently changed. But in an aquarium which contains also a due proportion of growing plants, and which is placed so as to be sheltered from the direct rays of the sun, they will thrive for a long time without any change, because the growing plants elaborate enough oxygen to supply the place of that which the fish have consumed.

Whence the plants obtain their aliment, carbonic acid, is evident. The water which enters the mouths of the fish, whether charged with atmospheric air or pure oxygen, surrenders the latter gas to be combined with the animal carbon, and makes its escape through the gills equally charged with carbonic acid.

A *perfect* aquarium, therefore, should have its proportions of animal and vegetable life so balanced, that when once duly set in operation, it shall need no interference from without. Each shall supply the other with the proper amount of respirable matter, and the water shall remain at all times equably aërated. But to effect this, a precision is required which I do not believe it possible to

attain. Nor is it necessary ; *there is no such thing in nature* ; and what Providence has not done for rivers and pools, it would be idle for us to attempt in an artificial reservoir. But how comes it, you may ask, that there is no such thing in nature ? Does not every stream and pond contradict you ? Certainly not. Stagnant water is, no doubt, kept in a wholesome condition mainly by the instrumentality of plants and animals ; but should there be a deficiency of either of the gases named, the wind that ruffles its surface acts mechanically in producing the same effect, and every shower of rain adds its quota. Watch the bubbles formed by the little waves that chafe against its miniature shores, or those that are incessantly rising and bursting as the drops patter on its dappled surface. Are not these bringing air and life to both animals and vegetables ? And as for running water, which owes its origin to springs, and most commonly abounds in carbonic acid gas, it is aërated at every cascade that it forms ; nay, its bubbling, and gurgling, and brawling, and sparkling, are but names for the sounds that it emits and the appearance it presents as it resists and impregnates itself with air. And this is the kind of water (which receives, too, its portion from the breeze and the shower)—it is this highly aërated water in which fish are most active ; for it should be borne in mind that, while a large number of species

of aquatic animals will thrive in river water but die in ponds, there are few, perhaps none, that are not benefited by being transferred from a pond to running water. A *perfect* aquarium exists, therefore, only in theory, and we shall derive more pleasure and profit from our toy (or whatever we are pleased that it should be to us), by making it the counterpart of a natural pond. As we propose to keep it within the house, we cannot avail ourselves of the wind and rain, but we may imitate nature as closely as we can. I would strongly recommend, then, every possessor of an aquarium not to set to work with a predetermined to make the occasions of aërating or changing the water as few as possible, but to study rather how he can most easily, and, consequently, most frequently, give his pets the refreshment which nature intended they should have.

So, again, with respect to temperature. Many kinds of fish are capable of sustaining extremes of high and low temperature. Gold-fish will thrive in the refuse water from steam engines, which is kept at a temperature of eighty degrees. They have been known, also, to bear being encased in a mass of ice, without receiving any detriment. Eels and Perch, according to Yarrell, are advantageously transported from place to place while in a frozen state, without destroying life. But these are exceptions; most kinds of fish are destroyed

by excessive cold. Let us consider what is their condition in their native ponds and rivers, and we shall see that they are rarely exposed to this ordeal. Water, in a pool, when its temperature approaches the freezing point, expands, becomes lighter, and rests on the surface until converted into ice. The film thus formed receives additions from above downwards, until, if the cold continues, the sheet has attained considerable thickness. Whatever fish may happen to be in the pond retire to the deepest water, and either lie at the bottom, or burrow in the mud. Under no circumstances does the pond begin to freeze at the bottom ; and indeed, unless the water be very shallow, the extreme cold never penetrates to the bottom at all. It is not correct, therefore, to say that the fish in a certain pond were subjected to severe frost, and did not suffer from it. They found it cold and cheerless enough, no doubt, to be thus entombed beneath a slab of ice, but that very ice kept off the cold from them ; it was warmer below the ice than above. But if frost continues for a very long period, and new deposits of ice extend downwards till they reach their haunts, having no means of escape, they are frozen in, and perish. This, however, rarely happens, except to shallow pieces of water, in seasons of unusual severity. In the winter of 1855-56, a pond on Chipperfield Common, in the county of Herts, was

thus frozen, and when, after some weeks, a thaw set in, and the ice disappeared, the edge was strewed with dead fish, though they belonged to a species,—Prussian Carp,—which is remarkably tenacious of life. True, they might have been suffocated; but whether they died from excessive cold or want of air, the ice, doubtless, was directly instrumental to their destruction. Now compare their condition in a pond with that in which they are placed in an aquarium, subjected to any temperature below the freezing point. The cold water here, as in the pond, rises to the surface and is converted into ice; the fish descend, but whither are they to go for warmth? In an aquarium, not only is the surface exposed to the cold air, but the sides. The water loses heat by radiation, not only from above, but from every part of the vessel, and the consequence is, that first a film, then a sheet, and, finally, a mass of ice, is formed close to the glass, and exactly fitting into the inside of the vessel. For want of taking the necessary precautions to prevent this unfortunate contingency, I have known all the fish (as many as a dozen) except a Prussian Carp and Tench, as well as all the insects in an aquarium, destroyed by a single night's frost, though the pond on the adjoining common was barely covered over. The precaution of throwing a piece of cloth over the vessel, in such a way that it

should hang down all round, would probably have prevented this catastrophe. I would suggest, therefore, that as it is undesirable to experimentize on the capabilities of fish for living in water that is never changed, so it is equally unwise to submit them to extreme cold, merely because there are on record instances of fish having been frozen and restored to life. Such a contingency is not one to which they are liable, in a state of nature, in the ordinary winters of this climate, and therefore one to which we have no right to subject them in their captivity.

The variety of aquatic plants which may be employed in keeping the water of an aquarium in a healthy condition for animals is considerable; but among them are some which it is impossible to grow, except in a vessel of very large size, and there are others which, though they will retain vitality for some time, will not flourish unless their roots can penetrate into soil of some kind. Others there are which, although in a state of nature they send their roots a long way into the mud or gravel, will flourish equally well without any such help. They appear only to be moored fast to the bottom, lest they should be swept away by the river's current, or washed ashore by violent winds; and there are some which under no circumstances are attached to the soil, but wander about at the pleasure of the winds and tiny waves,

now forming islands of verdure in the middle of the pond, and now grouping in masses near the bank. Of these various kinds we shall do well to confine our attention, at the outset at least, to the last two.

The dealers in stock for aquaria print and circulate lists of what they are pleased to call the most approved species for the purpose ; but these are hardly to be depended on, as they contain some which it is not possible to grow, except in a pond or in a reservoir of very large size, and even then are not very attractive, and others which require greater depth of soil than we can afford them ; while they omit others which might be grown with advantage.

We will suppose, then, that the convenient shops of London, where everything is to be had for money, are out of our reach, so that we must provide ourselves with what we want from the brooks and pools. We shall not have occasion to go far before we make a beginning, and have need of no implements but a small shrimping-net, such as is used by amateur fishermen who content themselves with groping about in the pools left by the tide on the sea-shore, and a tin box. The frame of the net is a stout iron ring a foot in diameter, which is attached to a light pole some five or six feet long. The tin box is shaped like a sandwich-box, but very much larger, and slung across the back by a leather strap.

At the first stream that we reach we shall probably notice a mass of green vegetation, entirely submersed if the current be swift, varying in hue from bright to the very deepest sap green, and waving to and fro like tresses of long, thick hair.



WATER CROWFOOT.

By digging with the net in the gravelly bed of the river, we shall have no difficulty in dislodging and bringing to land as much as we want of this at a

single haul. We select such specimens as suit our purpose. They are about six inches long : the stem is not thicker than whicord, and all the leaves show by their bright colour that they are in a vigorous state of health. From the lower part of the stem, near the joints, issue silvery-white, thread-like roots. These are the moorings of the plant ; which, though it only feeds on what it finds in the water, still requires to be fastened to the pebbles among which it grows ; and what better stay could it have ? See, we have not actually torn up a single plant, but only broken a few off near the base of the stem. The silvery threads attached to those which we have landed have never been buried beneath the soil, but were ready to perform their office whenever called on. Had the current carried away these stems when we dislodged them, they would have taken up their residence in the first pool of still water into which they floated. There they would have established themselves, and, perhaps, founded a colony, unless the ground were preoccupied. We have in reserve for them a more noble fate. Their silvery roots shall insinuate themselves among the gravel of our aquarium, and they shall have, moreover, a privilege which they would never have enjoyed in this rapid stream—that of flowering. The plant at present bears nothing but leaves as finely divided and as soft as fennel ; and thus they would have continued during the whole

period of their existence had they remained in rapidly running water, but transported to the still water of the aquarium, the plant will alter its character. In the spring, the newly-formed leaves, instead of being capillary (hair-like), as these are termed, will be flat and rounded, divided into three principal lobes, and notched. Moreover, they will float on the surface of the water, and thus enable the stem from which they spring to protrude above the surface large fine white flowers, tinged at the base of the petals with bright yellow, and so unmistakeably shaped, that the merest child shall at once pronounce them to be "white buttercups." *Ranunculus aquátilis* is the name the plant bears in science: "Water Buttercup," or "Water Crowfoot," its common name. This, then, is a plant that will interest every one, and will prove a prize indeed if it induces us to study Botany—if it tend to make the aquarium instructive as well as amusing. In spring we shall frequently find it covering the surface of ponds with its countless snow-white flowers, but were we not to watch its growth, we should scarcely be inclined to think two plants, so dissimilar as this green hair and that mass of blossom, identical.

Another species of Water Buttercup, *Ranunculus hederaceus* (Ivy-leaved Water Crowfoot), is common in brooks and marshy places; it too has white flowers, but small and inconspicuous, and the whole

plant is less pretty than the one which we have secured. Our next plant, therefore, for variety's sake, shall be of another genus.

Lower down the stream, where the water is less rapid, we fall in with another mass of submersed plants, rising nearly erect from the bottom. This too is fish for our net. We land it, and find a tuft of brittle stems thickly invested with flat clasping leaves, which are arranged in pairs and are almost transparent, and too delicate in structure to be able to bear the force of a current which passed through the fine leaves of the Water Crowfoot without injuring them. This is *Potamogéton densus* (opposite-leaved Pond-weed), a good plant for our purpose, because its leaves are arranged with beautiful symmetry, and are of a bright green tint, while their delicate texture will prevent them from imparting a heavy, dark character to the aquarium. In summer this will send up a cylindrical spike of dingy green flowers, which you will think more curious than beautiful. This, then, we value for its foliage only.

There are many other species of Pondweed which we should find after a little search, either of which would do very well in default of the handsome species which we have found. *P. natans* is different in its habit from the others that I have mentioned; the lower, submersed leaves are exceedingly narrow and long; but besides these, it bears elliptical opaque leaves, which float,

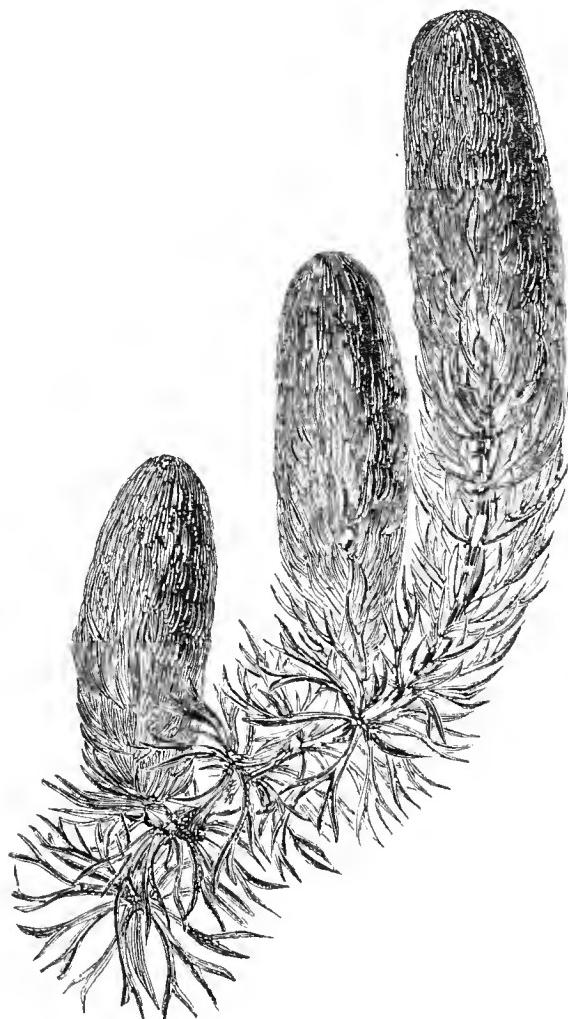
always with the same side uppermost, on the surface of the water, where they are a favourite resting-place or retreat to aquatic insects. This



POTAMOGETON DENSUS.

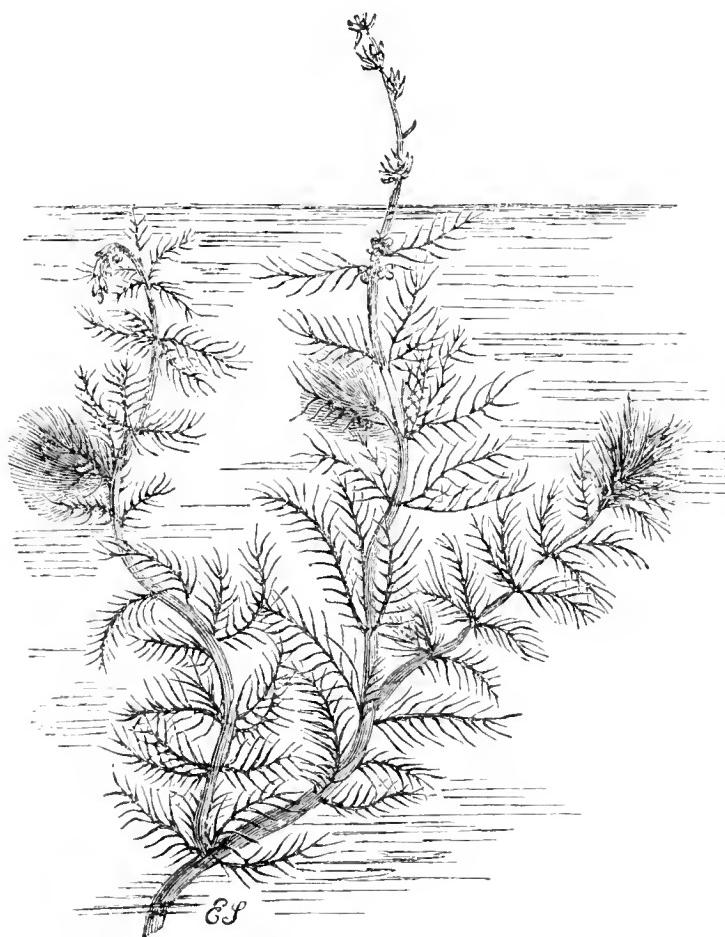
last is, perhaps, the most generally known of all the Pond-weeds, not only from its being common, but because its floating leaves, whatever the weather may be, and no matter how much the

water be agitated by the wind, are always dry and exemplarily neat. A small plant of this from a shallow pond will prove an acquisition. I say a shallow pond, or its long stems will occupy too much space; it being a peculiarity of this plant that its leaf-stalks always accommodate themselves to the depth of the pond in which they grow. If the water rise, they grow longer; if it sink, they too sink. Thus the dilated leaf is, under all circumstances, in a floating condition.



CERATOPHYLLUM DEMERSUM.

Ceratophyllum demersum (Hornwort) is another submersed plant, which we shall find useful in an aquarium, as its foliage, being finely divided, presents a large surface to the water, and probably elaborates a large quantity of oxygen. It bears inconspicuous flowers, but will help to give variety by its curiously tufted terminal shoots.



MYRIOPHYLLUM SPICATUM.

Myriophyllum verticillatum and *M. spicatum* (Water Milfoil) are also submerged plants, with

finely-divided leaves, resembling the last in habit. The latter species (Spiked Milfoil) is the most abundant. It bears its leaves four together, and sends up a spike of small inconspicuous flowers which expand above the surface.

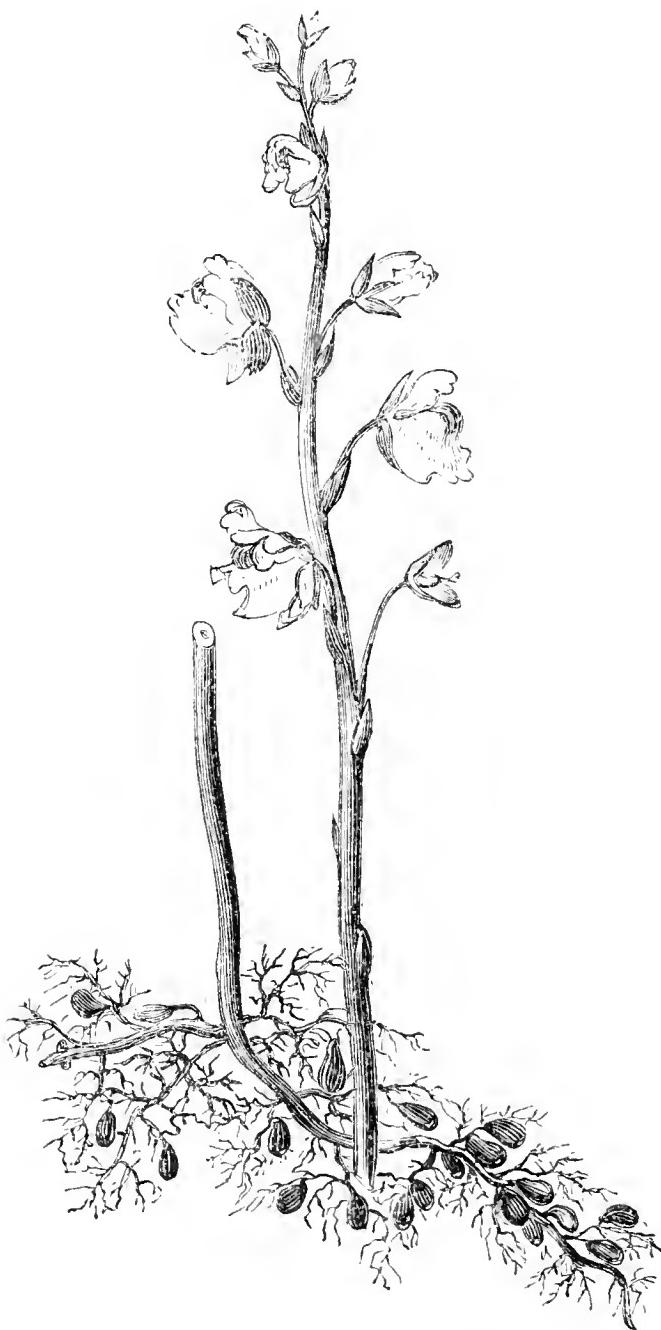


HYDROCHARIS MORSUS-RANÆ.

Hydrocharis Morsus-ranæ (Frog-bit).—A most

desirable plant for the aquarium, being of a convenient size, requiring no soil, and, moreover, having great pretensions to prettiness. Its stems spread horizontally along the surface of the water, and from them it sends down roots which do not require to be attached to the bottom. The leaves are kidney-shaped, and it bears, after *Ranunculus aquátilis* has ceased to blow, delicate large white flowers of three petals, which expand in succession.

Utricularia vulgaris (Bladderwort) we will, by all means, endeavour to domesticate, not only on account of its large, bright yellow flowers, which it raises in clusters of five or six together several inches above the surface of the water, but for the sake of the curious little organs from which it derives its name. All parts of the plant are plentifully furnished with minute membranaceous bladders, which, during great part of the year, are filled with water. When, however, the flowering season draws nigh, the bladders become filled with air, and buoy up the plant to the surface. As soon as the flowers are faded, the bladders are again filled with water, and the plant descends to ripen its seeds at the bottom. In order to facilitate this curious process, each bladder is provided with a minute valve opening inwards, through which, it is said, aquatic insects often enter, and thus are caught as in a trap.



UTRICULARIA VULGARIS.

Hottonia palustris (Water Violet), if we can succeed in making it grow, will be a very orna-

mental addition to our collection. Its leaves, which are all submersed, are of a delicate green hue, flat, and beautifully cut and fringed. The flowers, which are numerous, large, and of a delicate pink hue, stained near the centre with bright yellow, rise several inches above the surface. It is



WATER VIOLET.

said that it will not flower unless its roots can enjoy the advantage of a deep soil, but I have great hope that I shall succeed with it by planting it in a very small flower-pot, securing it by tying down moss over the earth, and sinking it in my

aquarium. This is a plan which, I think, might be adopted with advantage in the treatment of other aquatics. The pot should in every case be buried in the gravel, with the drainage-hole left open, to allow the roots, should such be their pleasure, to sally forth for extra nutriment.



VILLARSIA NYMPHÆOÏDES.

Villarsia nymphæoïdes, a very beautiful plant,

with floating leaves and large yellow flowers, would, perhaps, thrive under similar treatment. Its trivial name (*nymphæoïdes*) indicates its resemblance in habit to a water-lily. Unfortunately, it is not of common occurrence; so that, if we desire to possess it, we must condescend to apply to a dealer.

Stratiotes aloïdes (Aloe-like Water-Soldier) is another rarity to which we should do well to allot a space, if we can afford it. It resembles a miniature aloe, or the crown of a pine-apple, and is said to be a very desirable tenant for an aquarium. Small specimens of this plant are the most eligible, as the larger ones assume a coarse appearance, and have a tendency to decay. When successfully grown, it is rendered interesting by the contrast afforded by its stout, warlike leaves, and the feathery foliage around.

Glyceria fluitans, or *Poa fluitans* (Floating Meadow-Grass).—We must not fail to root out from some shallow pool a small plant of this, to be the representative of the grass tribe. It is so hardy that it cannot but grow under any treatment; and its long, green, riband-like leaves, always wet below and dry above, are very amusing, from their obstinate refusal to lie on their backs in the water, and the tenacity with which they persist in preserving a straight line as they bask on the surface. The plant will soon outgrow our dimensions, when

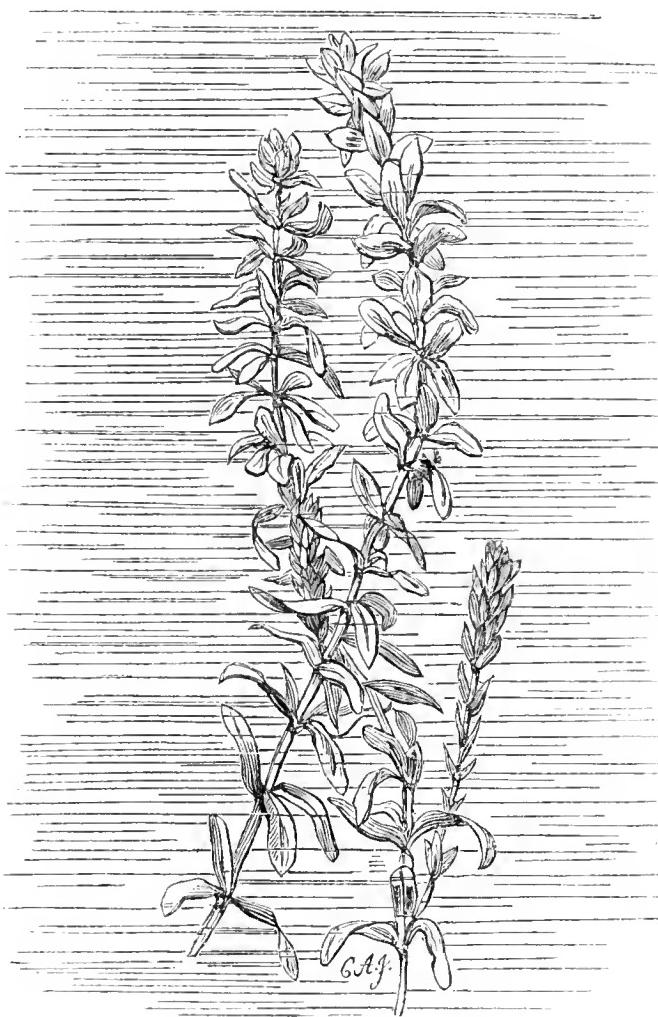
it may be thrown away, and a smaller one substituted.



WATER-SOLDIER.

Anácharis alsinastrum (Water-Thyme).—A useful plant in an aquarium, if rapid growth is desired. This is not a native, but was introduced from

North America a few years ago, and seems likely to prove as overpowering and unwelcome a colonist among vegetables, as the Norway rat is among animals; for not only does it threaten to get the

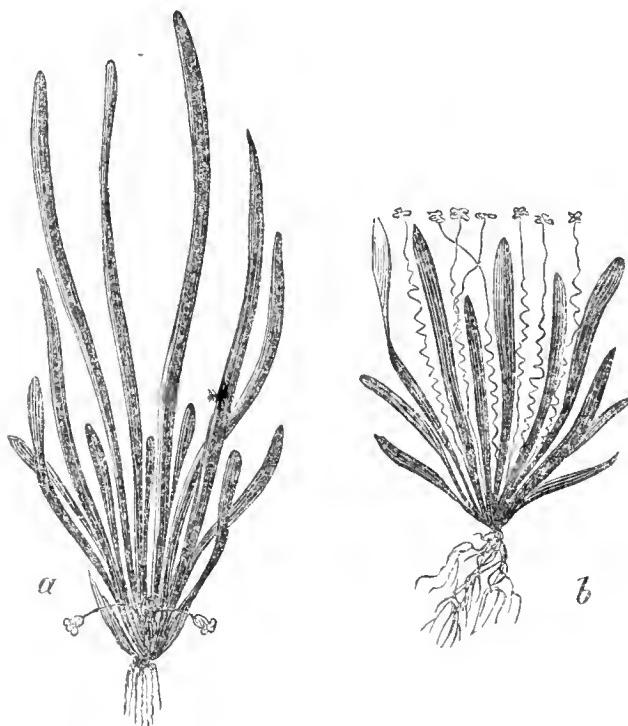


ANACHARIS ALSINASTRUM.

better of other less prolific aquatics, but to stop the navigation of our canals. Should it be unknown as yet in your neighbourhood, by no means

take pains to introduce it, as it is so tenacious of life, and grows with such wondrous rapidity, that the merest morsel, thrown only into a drain, may be the origin of irreparable mischief.

Vallisneria spiralis.—This is not a British plant, but was introduced from the South of Europe



a. Barren Plant.

b. Fertile Plant.

VALLISNERIA SPIRALIS.

many years ago, and has been cultivated by microscopists for the sake of the facilities which it offers for observing what is called the intra-cellular movement of the sap. Dr. Balfour, in his admirable "Outlines of Botany," thus describes it:—

"In the cells of *Vallisneria spiralis*, a dioecious*

* "Dioecious," bearing stamens and pistils on separate plants.

aquatic found in ditches in the South of Europe, an intra-cellular movement takes place, and is easily seen under the microscope, by laying a portion of the leaf in water, and making a slanting section at the end of it, so as to render the object more transparent by transmitted light. If the movement is not visible, the leaf may be immersed for a short time in water of the temperature of 70° or 80° . The piece of the leaf should always be prepared for an hour before it is exhibited. In the cells there are numerous green grains, some starch granules, and an occasional large nucleus,

which are covered with a mucilaginous fluid round the interior of the walls of each cell, as represented in the figure. This movement is seen not only in the cells of the leaf, but also in those of the root, flower-stalk, spathe (sheath of the flower), and calyx. The movement takes different directions in different cells, but it seems to keep the same course in every given cell; for if stopped, it resumes the same direction. The motion continues for many days in a detached piece of the leaf when kept in water. The rapidity of the movement varies from half-an-inch to five inches per hour. It is not connected with the general circulation of

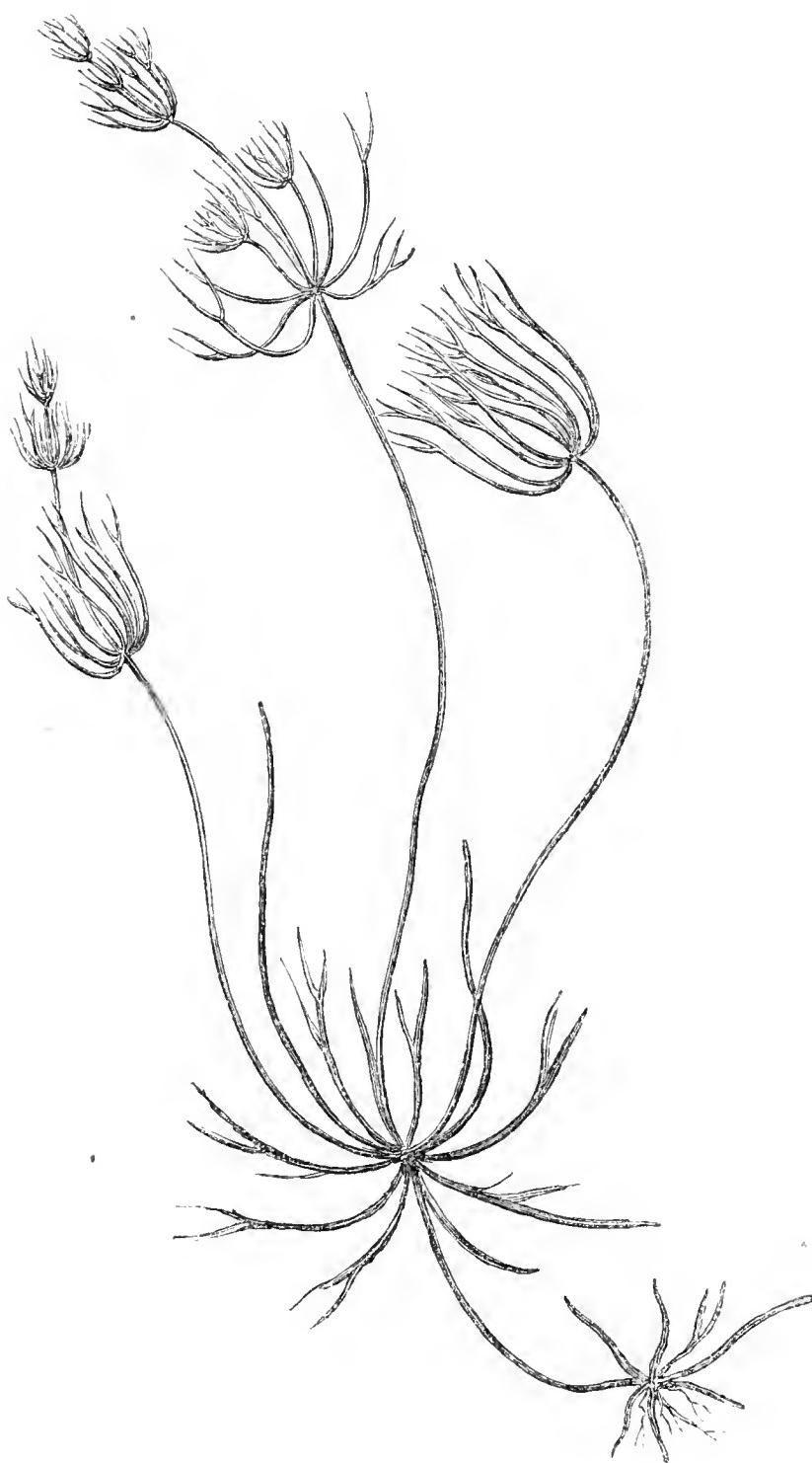


CELL OF
VALLISNERIA.

the sap, but is a special movement in individual cells."

Vallisneria is remarkable also for the structure of the stalks, which support the pistil-bearing flowers. They rise immediately from the stem, but, instead of being straight throughout their whole length, they are twisted like a corkscrew below; and thus, although they may be growing in water the depth of which varies, by opening or contracting the coil of the stem, they are enabled to raise the flower above the surface of the water. The staminiferous flowers grow on shorter stalks, and remain submersed, except when they shed their pollen. Being a native of a warm climate, it will not bear excessive cold; but it will increase rapidly in an aquarium if planted in a little soil or gravel.

Chara.—Curious leafless aquatics, composed of membranaceous tubes, which in some species are transparent, in others invested with a covering of lime. They are flowerless, but bear two kinds of fructification,—one, *globules* of a reddish or orange colour, containing a vast number of infinitely minute bodies, which, when the globule is fractured, escape with a spontaneous motion; and, secondly, *nucules*, oblong, toothed bodies, each of which is capable of producing a new plant. These plants offer the same facility for observing intracellular movement as *Vallisneria*. They are found carpeting the bottoms of slow streams, ditches,



NITELLA FLEXILIS.

and stagnant water, and frequently yielding a disagreeable odour like that of garlic. There are eight or nine British species. *Chara* or *Nitella flexilis*, the stems of which are glossy and pellucid, and *C. vulgaris*, in which they are opaque and brittle, are the most frequent. Trout and carp are said to grow to a large size where these plants abound; but whether they feed on the plant itself, or the insects which it harbours, is uncertain.



ILLECEBRUM VERTICILLATUM.

Illecebrum verticillatum (Knot-Grass).—A plant which has, I believe, never yet been cultivated in an aquarium, but might be attempted with advantage, and if it succeeded, would be found most attractive. In its native ponds, in Cornwall, it is a tangled mass of red thread-like stems, which bear very small ovate leaves, and very numerous

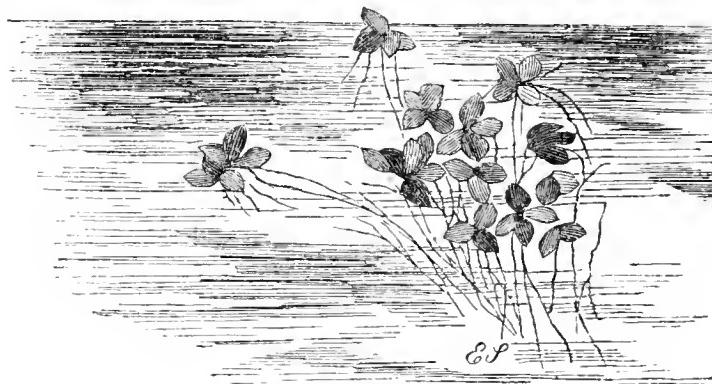
white star-like flowers, nestling among them in whorls. In its natural state its roots are deeply imbedded in mud; but it would probably thrive if planted in a small pot, which should be buried among the gravel at the bottom of the aquarium, in the manner recommended for the Water-Violet.



CALLITRICHÉ.

Callitriché (Water-Starwort).—Of this there are several species or varieties, of which *C. autumnalis* and *C. verna* differ little from each other, and being everywhere most abundant, are very convenient as temporary aërators. They thrive equally well whether attached or floating, and will consequently grow well from cuttings. The lower leaves are liable to decay and look shabby in winter, but the upper ones, which are crowded into the form of a star, are always green and

pretty. The mere points of the stems should be cut off, and dropped singly into the water, where they are sure to prosper, sending down long thread-like roots, which glisten in the sunshine like silver.



LEMNA MINOR.

Lemna (Duckweed).—A pond without Duckweed would scarcely be a pond; and an aquarium without at least a few plants of Duckweed would be altogether imperfect. Though too common and mean-looking a plant to have attracted the attention of any but ducks, insects, and botanists, the aquarium has brought it into notice, and people are surprised to find how much of what is curious and even elegant, there exists about that which they have been accustomed to designate, “the nasty green scum of the pond.” Perhaps had they read, before having seen it, that there grows in a certain country a floating plant, consisting of a single leaf, which, being destitute of a stem, sends down from its under surface a straight un-

divided root, bearing at its extremity a sheath or cap; that it does not often choose to flower, but prefers to shoot out, through a slit near its edge, two leaves, one on each side, like itself, which, when strong enough to be weaned, are cast off to provide for themselves; that mother and children, unlike most other plants, have no fixed home, but spend their whole life in cruising about on the surface of the water;—perhaps, I say, had many heard this history first, their curiosity would have been excited so far as to inquire what distant land produced this marvellous vegetable phenomenon; and would have thought the whole story a fabrication if they had been told that some 20,000 such plants were floating about in the pond hard by. Yet such is the veritable history of every frond of *Lemna*, which clothes the pond with a living and life-giving mantle, minute individually, but in the aggregate performing a most important office in the economy of nature, absorbing the noxious gases which are evolved from the corruption beneath, and sending forth countless streams of vitalizing air. Thus do the unconsidered objects of the creation quietly perform their Maker's will, all unnoticed, but not the less, on that account, performing His behests. And thus have we provided for us, in the meanest things around us, inducements to fix our thoughts on Him, whom we are bound to serve as faithfully

from choice and with the will, as the lower objects of the creation do in their passive obedience and from the necessity of their organism.

There are four different species of *Lemna*, to which, if the aquarium should ever tempt you to embrace the study of botany, you will soon be able to assign their proper names. Without some knowledge of the science, they are not very easy of discrimination.

The foregoing list comprises most of the plants likely to fall in our way, which are fit to grow in an aquarium. I need scarcely observe, that to grow all of them without an ample store of vessels is simply impossible. Let the reader select such as suit his fancy, and if he fails with any one, or grows tired of it, let him substitute another. But besides those which may be grown *in* an aquarium, as makers of oxygen, we may contrive some means of planting, and, if so, of growing round its edge, or on a raised island in its centre, many exquisitely beautiful gems of botany, which few persons but Mr. Ward and his disciples have ever attempted ; some of them plants which no one but the botanist has ever seen growing—rare, not from their being few in number, but from their inhabiting places which nobody thinks of visiting unless impelled by some powerful motive ; for who cares to splash through a marsh, or to pick his wary, weary way through a bog, unless he have

some attractive object in view? They are but an infant experiment with myself as yet, and the result may far from answer my expectations; yet out of the idea something may spring which other hands may bring to perfection. My experiment originated in the inquiry, What is to hinder me from growing, either on an island in my aquarium, or on a ledge of earth round its sides, some of the minute bog and marsh plants which, if entirely submersed, will not flourish? I have but to imitate their natural soil and condition, and I must succeed: their own soil I can bring with them, if need be, but decayed vegetable matter is abundant everywhere; their roots must have water within reach—a requisite which very little ingenuity will supply; and as for a moist atmosphere, that the vicinity of the aquarium will necessitate.

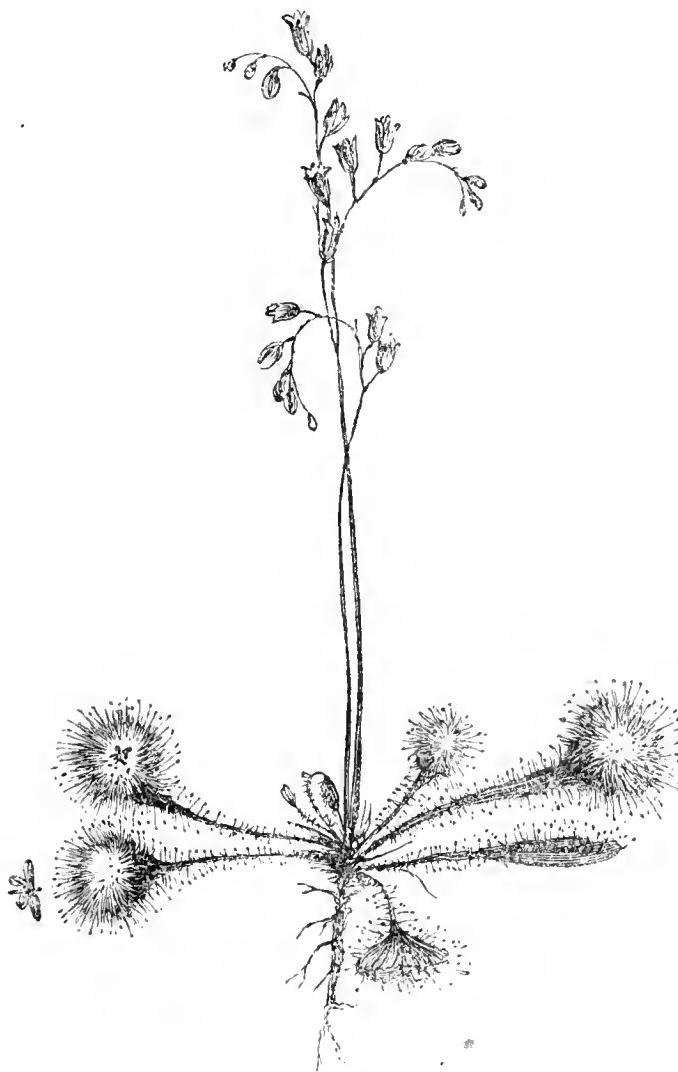
The plan, then, which I am trying, and which I venture to suggest, with such modifications as my readers may desire, is this: To procure a number of very small garden pots, of about two inches in diameter; to place in the bottom of each a tuft of soft moss, in order that there may be no escape; and to fill up with soil of various kinds suited to the requirements of the plants I intend to grow. Of these I either plant roots or sow the seeds, and then hang them up by stout hooked wire inside the aquarium, at such a depth below the rim that they may either just touch the water,

or be half or wholly submersed, according to the habit of each plant. I thus have a fringe of verdure, composed of such among the small aquatics and half-aquatics, as are most curious in structure, or most beautiful. Besides mosses and small ferns, I have at the present time in flower, Hepaticas, primroses, and a Crimean snowdrop. The pots may either touch the water, or if a thread of Berlin wool be allowed to hang from the drainage hole of the pot, into the water, it will keep the plant always moist.

The plants which I recommend for this purpose are the following :—

Drósera rotundifolia (Round-leaved Sundew).—If you can call to your mind any place in your neighbourhood where a stream from the hills, after forcing its way through rocks and moss-banks, is suddenly checked in its foaming course, and is lost sight of for a while as it winds lazily through a level tract of land, rich in rushes and cotton-grass, but unadorned by any shrubs save stunted grey willows and Dutch myrtle ; or if you can recollect some mossy hill-side, where the soft velvety turf suddenly ceases, and gives place to tufts of bright green, rose-coloured, or white moss, interspersed with knots of rigid rushes,—thither repair, armed with a tin box, for collecting specimens, and begin your search for Sundew. The stoutest of shoes are needful here, even in the

driest weather, and one must walk circumspectly even then; for it is only on tufts of rush and the prostrated branches of willows that one can venture to set foot at all, while a heavy step will set



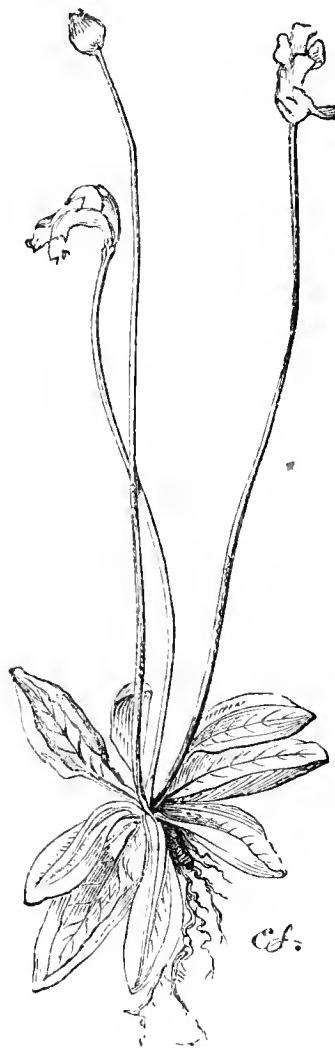
DRÓSERA ROTUNDIFOLIA.

the ground quaking for yards around, and a false one will precipitate you up to the knee, perhaps to the waist, in liquid mud. Here we are pretty

sure to find the object of our search. It lies close to the ground, but is easily distinguished by the deep red hue of its leaves. These are either circular, when the plant is *Drósera rotundifolia*, or oblong, in which case it is most probably *Drósera longifolia*. *D. Anglica* is larger, and of rare occurrence. All the species agree in having the upper surface of their leaves closely invested with red hairs, each of which is tipped by a globule of viscid fluid. Among these, any unhappy insect that may chance to alight is entangled, and held fast until it perishes. The flowers, which are small, white, and very pretty, only expand during sunshine. The plant seems well adapted for growing in a limited space, as it requires no depth of soil.

Pinguicula (Butterwort). — There are four British species of this singular family of plants, of which two only are of common occurrence. *P. vulgaris* is abundant in Scotland and the North of England, wherever the Sundews are found, as well as by the sides of alpine rills and lakes. It may be distinguished readily by its greenish-white convolute leaves, which have the appearance of being frosted, and are unctuous to the touch, as if they had been rubbed with butter. The flowers are large and purple, and grow singly on the summit of an erect slender stem, drooping on one side, so as to remind one of a violet. No more

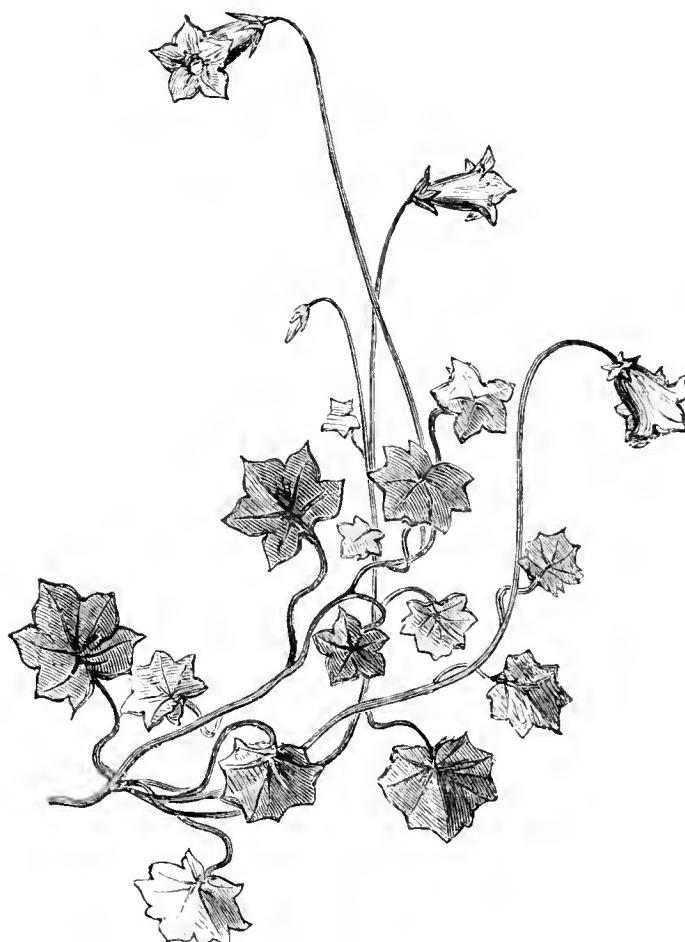
beautiful plant than this can be cultivated. *P. Lusitánica* is a smaller species, with light pink flowers, and in the West of England is a constant companion of the Sundew. Though less showy



PINGUICULA LUSITÁNICA.

than *P. vulgaris*, it is well worth growing. The Sundews and Butterworts should be planted in peaty earth or bog-moss.

Campánula hederacea (Ivy-leaved Bell-flower).—An exquisite little plant, with angular leaves of a tender green hue, stems not so thick as sewing silk, and elegant bell-shaped flowers, common in



CAMPÁNULA HEDERACEA.

the West of England, where it lines the margins of brooks, or creeps among rushes by the side of water-courses. A thriving tuft of this would be ornamental anywhere.

Sibthorpia Europaea (Cornish Money-wort).—Another West of England plant, well known to the dealers. It will not grow submersed, but creeps along the margin of brooks, or forms an elegant tapestry to watery banks, especially delighting in localities where it can hang down its minute orbicular leaves and tiny rose-coloured flowers in



SIBTHORPIA EUROPÆA.

graceful festoons, as if it knew in what its principal charm consisted. It is very easy of propagation, either by cuttings or seed.

Anagallis tenella (Bog Pimpernel).—A true Pimpernel, but very dissimilar in habit to every body's friend, the Scarlet Poor Man's Weather-

glass. In the West of England it is abundant wherever the two last-named plants are to be found, but, unlike them, is universally diffused throughout the kingdom. It creeps along the edge of rivulets, and may be at once distinguished



ANAGALLIS TENELLA, AND A. VULGARIS.

by its slender flattened shoots and delicate pink flowers, which are large in proportion to the plant, stalked, and cup-shaped, never expanding so wide as the scarlet species. The three last-named plants would require the same treatment.

Centunculus minimus (Chaff-weed).—This and the following may dispute the honour of being

the smallest of British flowering plants. They affect the same localities, though I do not recollect to have ever found them exactly side by side. A full-grown specimen of Chaff-weed, with stem, leaves, and flowers included, would furnish an



CENTUNCULUS MINIMUS.

elegant setting for a small-sized brooch. It must be hunted for on heaths, where the soil is damp and gravelly, especially in the little depressions where water has stood during winter; or an old cart-wheel rut may afford a few specimens. It may be detected by its resemblance to a stunted Scarlet Pimpernel, but its flowers are inconspicuous. It might, no doubt, be easily raised from seed.

Radiola millegrana (Flax-seed).—A full-grown specimen of this tiny plant would, perhaps, overtop Chaff-weed by half-an-inch or more, but would nevertheless carry off the palm for lightness, its stems and foliage being much less robust than those

of its rival. It is also more elegant in its habit of growth, and would well repay the trouble of cultivation. It delights in the same situations, and is doubtless equally susceptible of being raised from



RADIOLA MILLEGRANA.

seed. It generally grows in considerable quantities together; hence it becomes conspicuous in spite of its excessive minuteness. Fine gravel, with a slight admixture of leaf-mould, would suit these two plants.

Montia fontana (Water-blinks).—A succulent herbaceous plant, two or three inches high, with opposite leaves, which are broad at the base, and pointed; the flowers are minute, white, drooping when in bud, and are succeeded each by a 3-valved and 3-seeded capsule. It is common in or near

shallow brooks of running water, and will thrive either totally or partially submersed.



MONTIA FONTANA.



ELATINE.

Elatine (Water-wort).—Another very minute water-plant, about an inch high, which, like the

last, will grow either totally or partially submersed. It has creeping roots, small rose-coloured flowers, and seeds which are remarkable for their being beautifully marked as with carvings. There are two species which closely resemble each other, and grow at the bottom of lakes, where they form

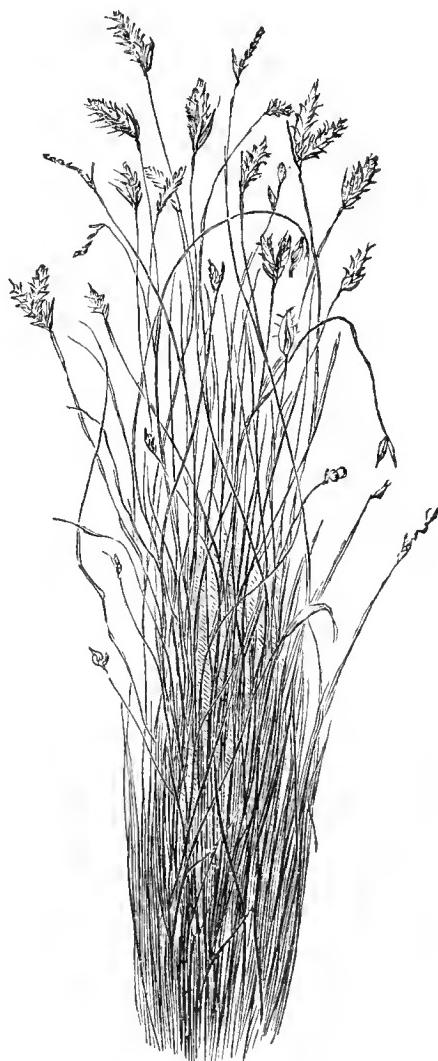


SUBULARIA AQUATICA.

a dense carpet of verdure. When not submersed, the foliage assumes a deep red hue, which on the edge of an aquarium would produce a very pleasing contrast. Both species are rare.

Subularia aquatica (Awl-wort).—This also is

a lake plant, and might well be employed either to carpet the bottom of the aquarium, or to decorate its edge. It is frequent on the shallow margins of alpine lakes, in that respect differing from



SCIRPUS SAVII.

Elatine, which is not confined to mountainous districts.

Scirpus Savii.—A minute bulrush, from four to

six inches high, not unfrequent in marshes in the West of England, and sold in Covent Garden under the fancy name of Isidora.

Hydrocotyle vulgaris (Marsh Pennywort).—A generally diffused plant, to be found in marshes, by lakes and near rivers; in short, wherever the ground is very wet. Being thus indifferent as



HYDROCOTYLE VULGARIS.

to soil, it cannot be difficult of cultivation. It belongs to the tribe of umbelliferous plants, the generality of which, however, it little resembles in habit. The flowers are inconspicuous, but the leaves are pretty, rising from the ground without any apparent general stem, stalked, circular, and notched at the edge, altogether not unlike the leaves of the better-known *Cotylédon Umbilicus*, or “Penny-pies.”

Lysimachia Nummularia (Money-wort Loosestrife).—A plant very commonly employed in the construction of rockwork, and too large to be introduced into an aquarium, though it might be



LYSIMACHIA NUMMULARIA.

used with advantage in decorating the exterior or stand. It is common on the banks of rivers, from which it may be often seen hanging down in graceful festoons, its spray being adorned by a

double row of roundish glossy leaves, and large bright yellow flowers.

The above are all flowering plants, and the list is, I doubt not, capable of several additions. But, besides these, there is a vast number of Mosses



BRYUM ROSEUM.

which may be picked up in watery places, any of which might be tried with advantage. In addition to the two figured at pages 21 and 22, I will here only mention *Bryum roseum* and *Mnium undulatum*, the former deriving its name from having its stem crowned with a rose-like tuft of bright green

leaves, to be found in damp woods, but not common in fruit; the latter, scarcely less elegant, abounding in every damp shady hedge or wood.

Many of the Hepaticæ, or Liverworts, might be attempted also with great probability of success. Of these some are destitute both of stem and

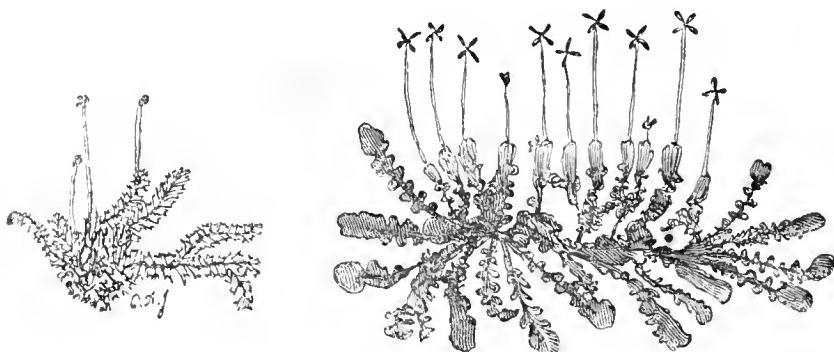


MNIUM UNDULATUM.

leaves, consisting merely of an irregular frond, which emits roots along the whole of its length, and sends up a delicate crystal pillar, bearing as its capital a black shining globe, which, when ripe, splits into four valves, and scatters its spores on all sides. Others have much the appearance of mosses, from which they may be distinguished by

their leaves, arranged in two rows on opposite sides of the stem, or by their fructification just described. These are to be found in moist woods, by rivulets, springs, or in marshes. One of them, *Riccia fluitans*, requires no more cultivation than duckweed, but flourishes on the surface of the water.

Should any one object that all this care bestowed on the aquarium harmonizes ill with the homely flower-pot in which it stands, we will allow that



JUNGERMANNIA EXCISA AND J. RESUPINATA.

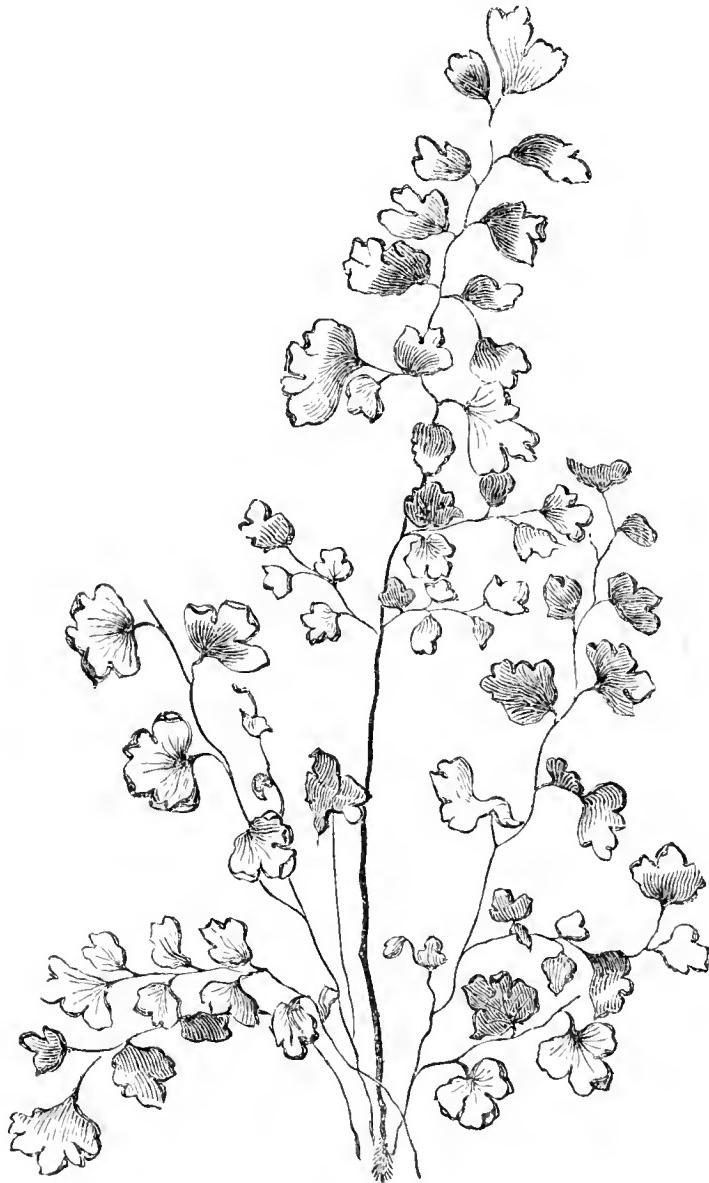
there is some reason in the objection, and proceed to remove it. Let the glass be inverted in a larger flower-pot, and let the flower-pot itself be set to stand in a saucer of water. We may then plant around the rim, beneath the glass, any plants that we like—ferns, mosses, or flowering plants. Or throw over the edge of the aquarium several threads of Berlin wool, allowing one end to touch the water and the other to hang outside. They will act like siphons, and keep the earth

below constantly moist. In the course of a few weeks, *Lysimachia* and *Sibthorpia* alone would send down festoons of foliage sufficient to conceal everything unsightly; and, to tell the truth, it was this object which I had in view when I named them as fit plants for our purpose. We should, however, avoid employing any plants here which are not either aquatics or half-aquatics; and we must exclude, also, such as would grow tall enough to obstruct the view of the aquarium and its contents.

The Maidenhair Fern (*Adiantum Capillus-Veneris*) would do very well for this purpose, or any other small fern which delights in water. *Hymenophyllum* (Filmy Fern) is a minute and very beautiful fern, worthy of having any amount of pains bestowed on it. Any species of *Lycopodium* that is found to succeed in a Wardian case would also thrive here. But the case is one in which good taste, directed by a little judgment, will suggest some arrangement of the means within reach far more likely to answer than the most explicit directions.

An aquarium being thus stocked with aquatic plants, furnished and aërated, we may say, for its animal tenants, our next care must be to select from among such fish as are within our reach those which will best bear confinement. Trout are to be found in most gravelly streams, espe-

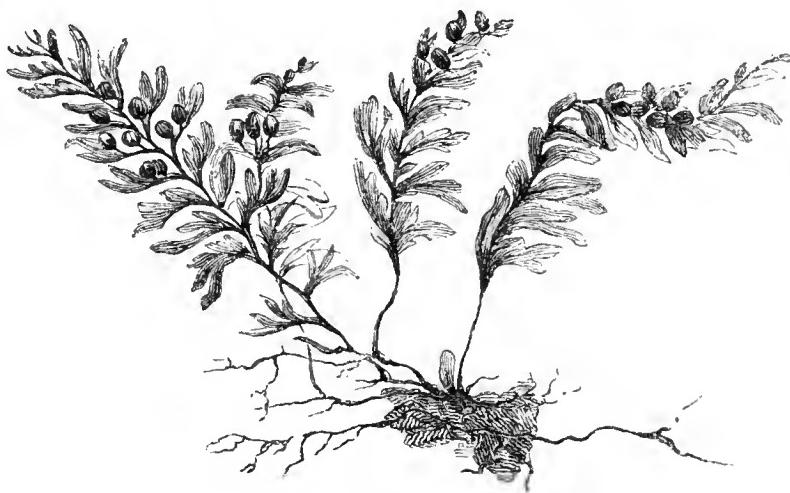
cially those that are rapid in their course ; and if we could persuade them that a glass vase, with the



ADIANTUM CAPILLUS VENERIS.

daily admiration of their owner, is a more desirable dwelling than a gurgling brook, with a secure retreat under an alder stump, and liberty to sally

forth when they please, on a chase after minnows and May-flies, we would take them under our care without hearing the claims of any others among the finny tribe. But to a trout, I fear,



FILMY FERN.

our limited artificial lake would be no better than a condemned cell; his silvery sides would soon tarnish, and his crimson spots grow dim; he would pine for freedom and sparkling cascades, and, by an untimely death, disappoint us at the very outset of our enterprise. We will leave him, then, to enjoy his arrowy glancings through his native water-courses,—to choose, as is his wont, the swiftest current wherein to show his skill in sustaining his motionless balance when all around is turbulent, until some angler more wily than himself shall entice him from his haunts, and we will content ourselves with less noble captives.

Our sport requires neither the skill nor delicate apparatus of the angler. A shrimping-net and a bait-can—or, wanting that, a watering-pot, or a large open-mouthed bottle—are all that we need; and unless the neighbourhood be very barren in ponds and rivulets, there is little doubt as to our success.

It is somewhat of a mystery how our common wayside ponds were, in the first instance, stocked with fish; but certainly fish do abound in the most unpromising localities. Yarrell mentions an instance in which a piece of water, into which wood and rubbish had been thrown for years, was ordered to be drained out. Persons were accordingly employed; and, almost choked up as it was by weeds and mud, so little water remained, that no one expected to see any fish but a few eels, yet nearly four hundred tench, of all sizes, and as many perch, were found; and among them, one tench weighing eleven and a half pounds, which had become a fixture in a hole, to which he had resorted in his early days, and to which, when he was grown so big that he could not get out, he was obliged to accommodate his shape and dimensions.

A short time since, I was told by some boys that there were some Prussian carp in an inconsiderable pond hard by my own house. A few sweeps with a shrimping-net brought out not

only Prussian carp in abundance, but tench and common carp, the latter of some size. You must not therefore conclude that no fish are to be had in your neighbourhood, because the ponds are in appearance only fit to be inhabited by frogs and newts. These are there, no doubt; but most likely they are not the sole tenants. Should you, however, catch a newt, do not reject him on account of his ugliness; he has many points about him which entitle him to a trial in the aquarium: and if an ungainly, over-grown frog or toad crawls out from the mass of mud you have landed, though you may not choose to take him home to become a pet, you will be surprised at the instinctive sagacity which he displays in his efforts to regain the water. No matter whether the pond be within his sight or not, ten to one that he does not start by the nearest road to the water, and you must be quick to intercept him.

But even for the aquarium neither frogs nor newts are to be despised, at least in the earlier stages of their growth. The spawn or eggs of the frog should be collected early in spring; at which season it is to be found at the edge of every pond, forming large masses of gelatinous substance, and enclosing a multitude of black globular bodies no bigger than hemp-seed. A portion of this substance should be placed in the aquarium, and daily examined, in order that all the changes may

be duly noted. So transparent is the medium in which the egg is contained, that the development of the principal parts of the animal is noticeable before it is hatched. The head, tail, and branchiæ, or gills, become first apparent ; to these succeed



TADPOLES.

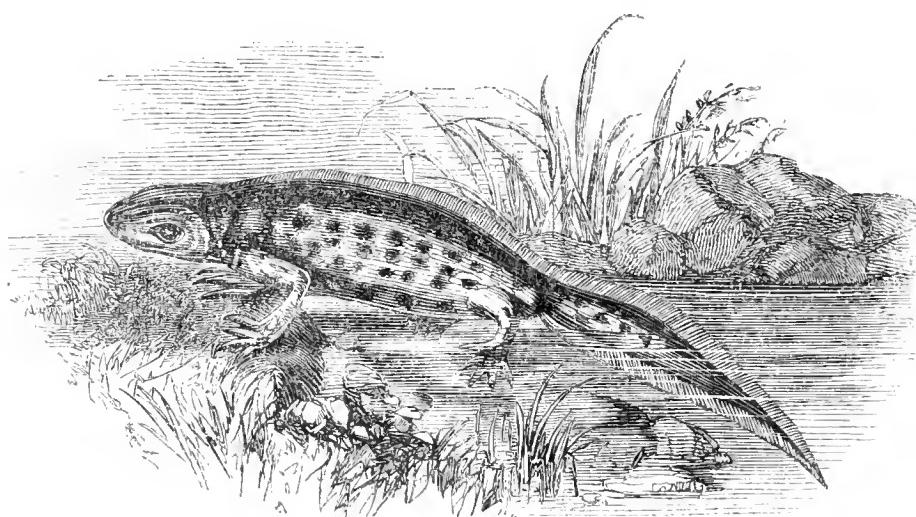
the nostrils and eyes, and the blood is seen to circulate through the branchiæ. If the temperature be tolerably high, the little creature soon extricates itself from the membrane of the egg, and commences its tadpole life. The branchiæ now become divided into two main stems on each side, each stem consisting of about four leaves. "The present state of these organs, which have now arrived at their maximum of development, constitutes one of the most charming objects for microscopic observation which can be conceived, and to view which a very high power is not necessary nor even desirable. The current of the blood

proceeds in regular pulsations at each contraction of the heart, passes up each stem or main branch of the branchiæ, and a distinct stream is given off to each leaf; it is propelled to the extremity, and then returns down the opposite sides in the most regular manner, and the parts are so transparent that every globule of blood is distinctly and beautifully visible." (Bell's "British Reptiles.")

How the branchiæ become altered in shape, and are finally withdrawn within the body of the animal; how the body enlarges, and the tail lengthens, till the creature becomes physiologically a fish; how the legs and toes bud forth, and the tail dwindles away and disappears; how the gills close, and the tadpole, become a frog breathes by lungs through its mouth;—all these transformations will, in their turn, afford ample subjects for examination. While undergoing these changes, they live principally on decaying vegetable substance, acquiring a taste for animal food by devouring those among their comrades who are beforehand in acquiring legs. In their perfect state they live principally on worms and insects, and respire not only through the mouth, but through the skin. To this latter faculty is to be attributed the power they possess of remaining a long time under water.

Of the Newt there are two species common in Britain; the Warty Newt (*Triton cristatus*), and

the Smooth Newt (*Lissotriton punctatus*). The development of these little animals is no less curious than that of the frog. Indeed, with the exception that the tail is not absorbed, but is a permanent

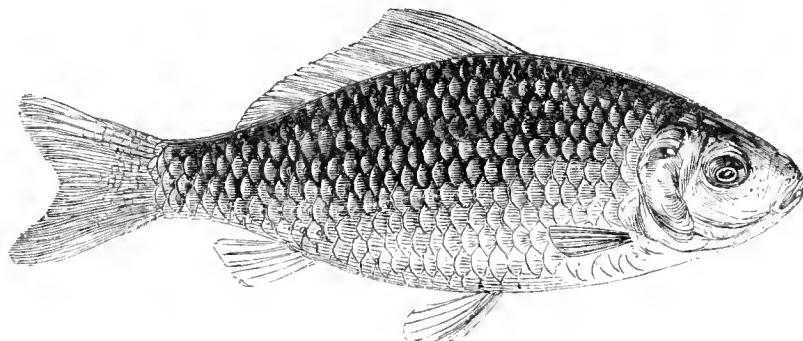


LISSOTRITON PUNCTATUS.

appendage of the animal, there is little difference in their physiology. In both species the males are distinguished in spring by a ridge or crest which extends over the whole length of the back. The females lay their eggs singly in the leaves of aquatic plants which rise above the surface or line the edge of ponds, where they should be searched for in spring, and carried to the aquarium, that the whole development of the animal may be observed, from its hatching to the period of its becoming a perfect reptile. Care must be taken to place neither the tadpoles of the frog nor of the newt in the same vessel with carnivorous insects

or large fish, or they will soon be devoured. Being incapable of defence, they are no match even for the Water-Boatman, who makes nothing of taking in tow a newt three or four times his own length.

To catch fish in stagnant water, a rapid sweep of the net is necessary, either among weeds or, in cold weather, tolerably deep in the mud. Among those which are most easily caught, and best adapted for an aquarium, are the Prussian or Crucian carp, either name being loosely applied to two species or varieties of *Cyprinus*, *C. Gibelio*, and *C. carassius*. They are much alike, being

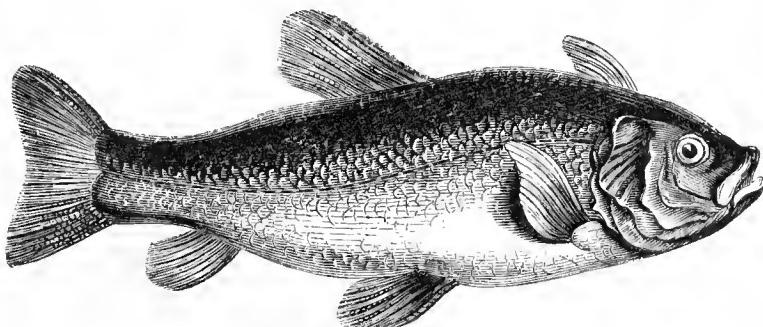


PRUSSIAN CARP.

mainly distinguished by their different proportions; the depth of the former being to the length as one to three, in the latter as two to five. The scales are large, dark above, almost white below, but shining everywhere with a golden metallic lustre, the iris golden, the fins and tail tinged with orange-red. The common size attained by this fish is said to be about half-a-

pound ; but we must provide ourselves with much smaller specimens. Two or three about an inch in length, as many more from three to four inches long, will consume no more oxygen than one large one, and will be far more amusing. Prussian carp seem to be sociable fish, and may often be seen leisurely swimming about, two or three together. I fear, however, that they are only fair-weather friends ; I, at least, cannot praise them for their good companionship in misfortune. A short time since, I had a specimen of *Vallisneria* growing in a tall glass, in which I had also placed a brace of very small Prussian carp. Going to examine them one morning, I found that the glass had been accidentally broken, so that the water had escaped, and the fish were lying extended on the wet sand at the bottom. Taking them out, I found that one of them had eaten half a side of the other, which, of course, had died under the operation. The murderer had grown corpulent from his meal ; and when placed in another vessel of water, after clearing himself from the bones of his deceased friend and the sand which adhered to his sides, sailed off quite at his ease. These fish, then, are very tenacious of life ; they will bear being out of the water twenty or thirty hours, and seem to require very little oxygen, as they will thrive in water which has become unfit for the respiration of any other fish.

The Tench (*Tinca vulgaris*) is even more tenacious of life than the last. Ordinary river water contains one per cent. of oxygen ; but the tench is able to breathe when the quantity is reduced to the five-thousandth part of the bulk of the water.

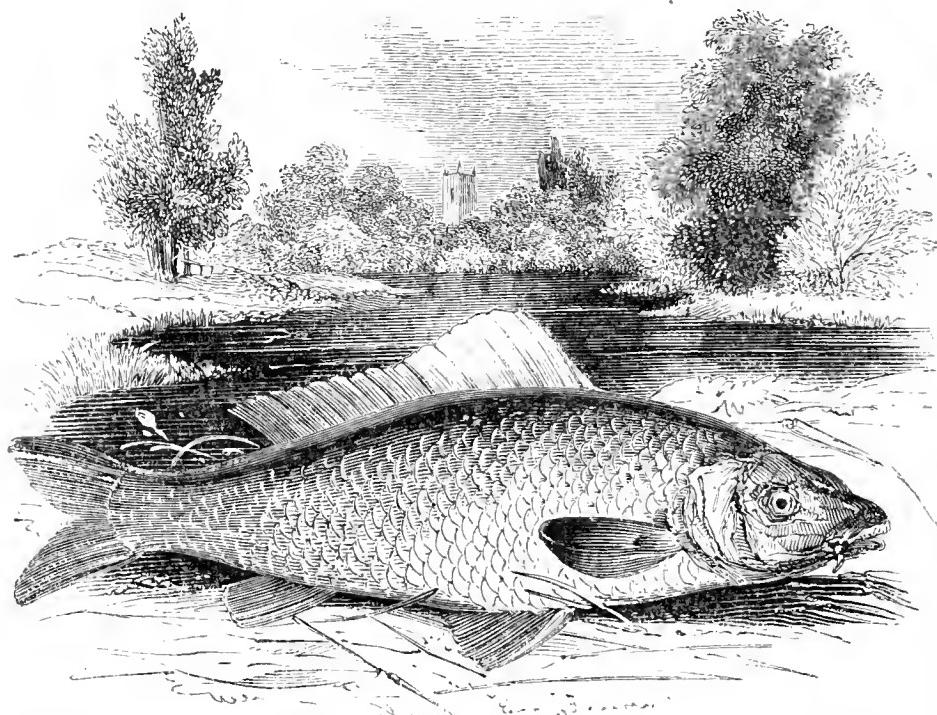


TENCH.

Old authors believed that it was not only long-lived itself, but the cause of long life in others. When a carp or other fish is wounded, they say, the tench is the doctor to whom he applies for relief ; he rubs his wound against the body of his medical adviser, and with the most beneficial results. In an aquarium the tench is sedate in his habits, and is grave enough for a physician of high eminence. He is characterised by his minute scales and olive-green hue, which near the head is tinted with purple, like shot silk.

The Common Carp (*Cyprinus Carpio*) in tenacity of life far outstrips all competitors. It may often be seen exposed for sale on the slabs of the London fishmongers in a living state, and requir-

ing only the occasional refreshment of being sprinkled with water. Several authors have stated that it is a common practice in Holland to keep them alive for three weeks or a month, by hanging them in a cool place, with wet moss in a net, and feeding them with bread steeped in milk,

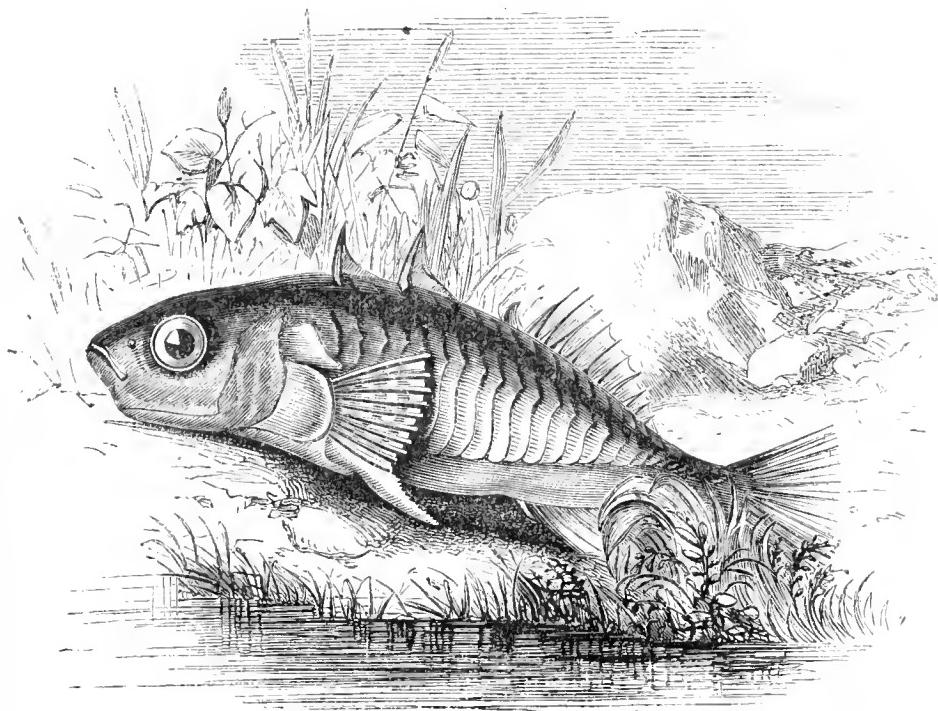


CARP.

taking care now and then to refresh the animal by throwing water over the net in which it is suspended. In their native ponds, carp are in the habit of burying themselves in the mud; it is necessary to fish deep for them with the net, and to move the net quickly, as they are active in their movements when alarmed. The most obvious

points of difference between them and Prussian carp are the greater length, sharper head (which is generally slightly bearded), the wavy outline of the dorsal-fin, and the golden olive-brown colour, which is much darker about the head, fins, and tail.

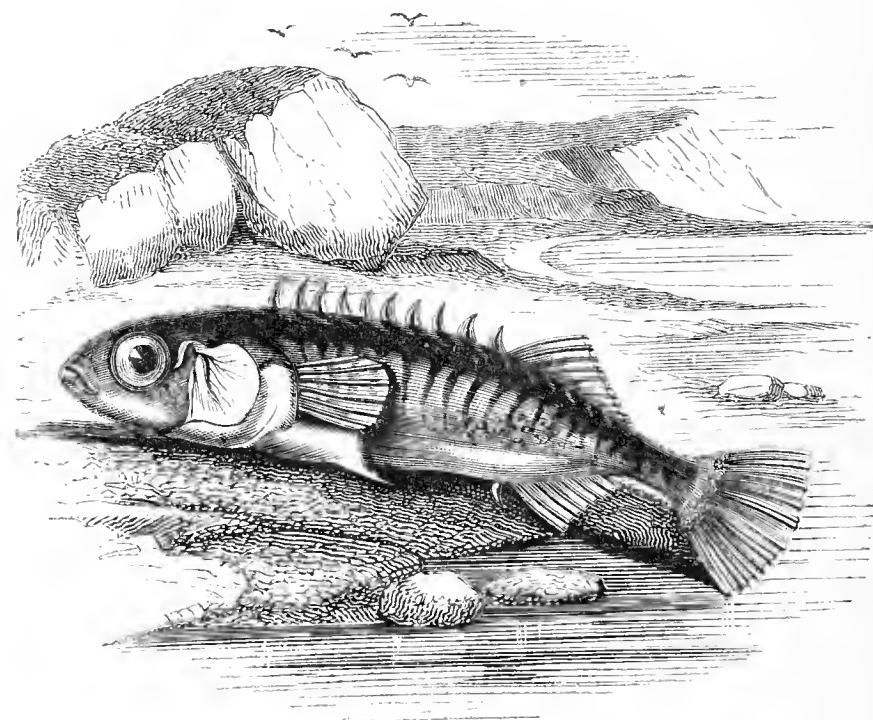
Stickleback .(Gasterosteus).—Captivity is said to subdue the spirits of the most animated. If



THREE-SPINED STICKLEBACK.

this be true of sticklebacks, they must be, when at freedom, the very princes of vivacity. Thrown into the aquarium, they dart off like boys let loose into the play-ground; shooting rapidly in all directions, they make themselves acquainted at

once with the limits of their new residence, and in the course of a few hours have resolved on their future mode of conducting themselves,—that is, in a few words, to pry into everything, to attack every other living thing that meets them, to swallow everything moving in the water that is not too big to enter their mouths, and to worry their



TEN-SPINED STICKLEBACK.

fellow-captives to the extent of their ability. Like biped thieves, who walk on earth and live in air, they resort together in bands; but, unlike them, they fall out whenever a booty is in sight. They associate, in short, not for the advantage of combining in attack, but for the pleasure of quarrelling

about their prey. Does a particle of stick or any such thing descend through the water, it is seized and swallowed by the nimblest of the pack ; but, when found to be unpalatable, disgorged for the benefit of the next in activity, who has regarded the operation with wistful looks ; and so on till the rejected morsel reaches the bottom, where, as it has ceased to move, it is allowed to remain. Does a caddis-worm venture to poke his head out of his case while a stickleback is nigh, he is lucky if he can withdraw within his shell, except at the cost of a bruised head or a pinched foot. Does a water-boatman come by, a snap is made at his oar : but this is a customer who resents such treatment, and a tustle takes place, which ends in the rapid retreat of the assailant ; the great black water-beetle even is compelled to put up with the indignity of having his horns pulled or his back tapped, as often as he shifts his quarters. If a worm is thrown in, the whole band seem to scent it simultaneously : the first comer swallows it as far as his capacity will admit, darting away from his envious comrades and doubling as cunningly as a hare ; but in vain : a larger and stronger member of the family has descried a writhing unswallowed tail projecting from his mouth, and unscrupulously seizes it, starts at full speed across and round the aquarium, dragging his victim with him, not, however, without being watched by a

brother in arms as strong and as predacious as himself: for no sooner has he succeeded in literally taking the food out of one neighbour's mouth, than it is fastened on by another, who is not to be so easily managed. Each now has an end of the hapless worm, who finds himself half-eaten by two enemies at once, whose noses at last meet in defiance. These two now perform a course as amicably as two greyhounds in a leash. At last, the weaker or the less persevering gives in, disgorges his half, and the conqueror makes his meal at a gulp, or is in his turn obliged to surrender his prize to some new robber.

Sometimes a fiery little fellow, with unflagging insolence, resolves on persecuting some other member of the community, one, perhaps, twenty times as big as himself; for instance, a meek, unarmed, inoffensive Prussian carp. The latter may be quietly poising himself in mid-water—motionless, except that a slight undulation is perceptible in one of the fins. The stickleback, a little above him, just so far behind as to be out of sight, with spines erected, and with an eagerness of gaze which one would scarcely believe possible in a fish, detects the movement, darts with the rapidity of lightning on the membrane, gives it one shake, and retreats. The carp, disapproving of this salutation, moves off to another resting-place, where, alas! he finds no rest: his annoyer is not to be so

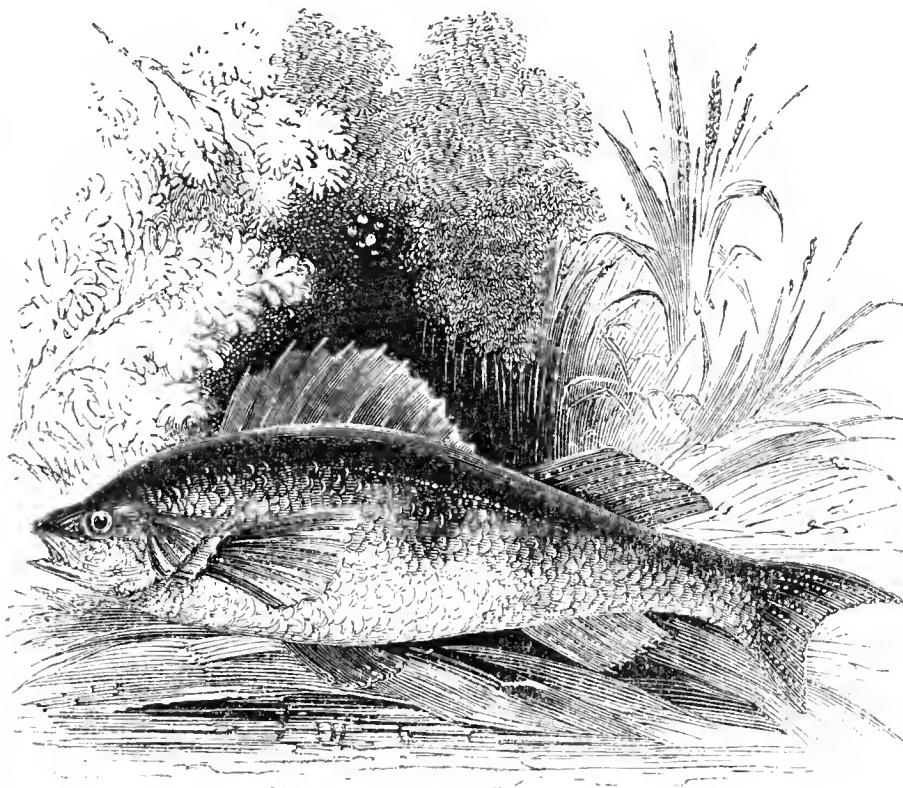
easily baulked in his schemes of persecution, but varies his attack, in so far that the tail is now the assaulted part. The poor carp makes no attempt at retaliation, gaining, however, no mercy on that account, and the consequences soon become apparent in the altered guise of his fin and tail,—yesterday so trim and neat, now terminating in a ragged white fringe. To have a peaceable aquarium, then, you must not be tempted to introduce sticklebacks into it. Terrible tales are told of their even impaling their fellow-captives on their formidable spines; and these I can well believe, though I have never verified them by actual observation. Several sticklebacks I have seen lying dead under very suspicious circumstances, but they *may* have died from natural causes. And I can say one word in their defence, that if they have slaughtered one another, they have allowed a very minute bleak to reside among them for some months without molestation. Dr. Lankester, in his "Aqua-vivarium," gives a most entertaining account of these little tyrants, adducing some traits in their character which have never fallen under my notice, and tending to prove that, quarrelsome and pugnacious as they are, in their parental relations they are most exemplary. This may well be, since every one knows with what intensity even bears and tigers will defend their young. There are seven species of sticklebacks

all agreeing—it is pleasant to find that they do agree in anything—in having the body covered with shining plates instead of scales, from three to fifteen spines between the head and dorsal-fin, which they can erect and depress at pleasure, and one projecting spine on each side. Many of the species are found both in fresh and salt water; the most common being the three-spined and ten-spined. In the latter, the spines are arranged along the back in a double row. I am inclined to think that the sticklebacks, and perhaps many other small fishes, are often confounded, by those who have not examined them minutely, under the general name of Minnows.

Perca fluviátilis (the Common Perch).—For a full account of this handsome fish, I must refer my readers to Gosse's "Natural History, Fishes."* The perch may be at once distinguished by its rigid, spinous dorsal-fin, bright red fins, and the dark-brown bands which diversify its sides. If there is any difficulty in taking these with the net, they may be caught by angling with a small red-worm; and, provided that they do not swallow the hook, they do not appear to suffer from the operation. Small specimens should be selected for the aquarium; for, although larger ones will remain alive for some time, they do not become reconciled to confinement. I have kept one about

* Published by the Society for Promoting Christian Knowledge.

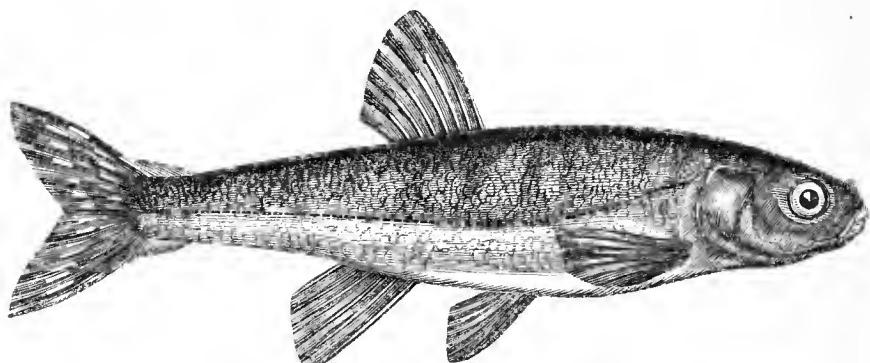
six inches long for about a fortnight ; but it looked so ill at ease, and so disproportioned in size to its fellow-captives, that I restored it to liberty.



PERCH.

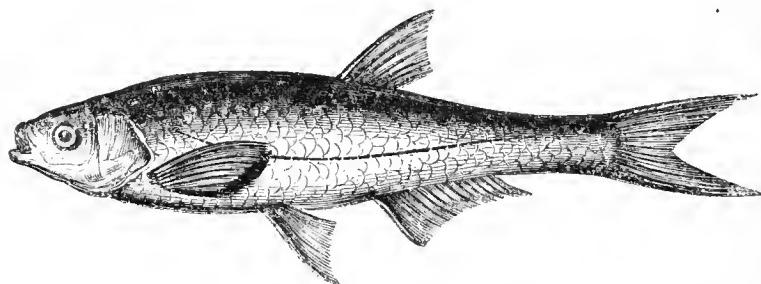
The Minnow (*Leuciscus Phoxinus*).—This very active and amusing little fish should have a place in every aquarium, as it soon becomes reconciled to captivity, and is as ready to eat as the stickleback. Though the minnow never exceeds three or four inches in length, full-grown specimens are not so desirable for an aquarium as those of less

size, being less active and more sensitive of changes of temperature.



MINNOW.

The Bleak (*Leuciscus alburnus*).—This, also, is a very active fish, and thrives well in captivity. It is of a brighter hue and more elegant shape than the minnow. In an aquarium it is seldom at rest, frequently indulging in a course round its

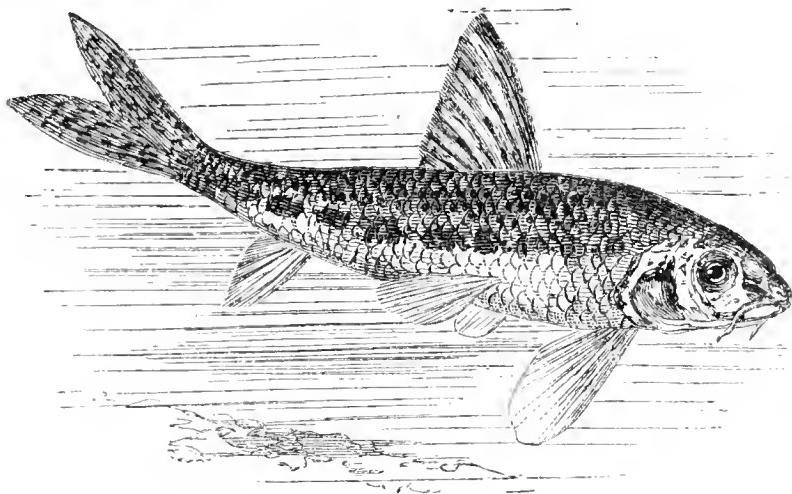


BLEAK.

prison, but more generally remaining poised in mid-water, advancing slowly in one direction for an inch or so, and then suddenly altering its attitude by a graceful movement of the tail. The scales are silvery white, with a green hue above;

the fins, transparent. It is from the silvery substance found under the scales of this fish that artificial pearls were formerly made, being collected in water and injected into hollow glass balls. An interesting account of the process is to be found in Beckmann's "History of Inventions."

Small specimens of the Roach (*Leuciscus rutilus*) ; the Dace (*L. vulgaris*) ; the Chub (*L. Céphalus*) ; and the Red-eye (*L. erythrophthalmus*) ; all or some of which are to be found in canals and slow rivers, will afford a pleasing variety in the collection ; and being similar in habits to the bleak, will probably thrive equally well. I do not, however, recommend that any experiments should be tried with specimens exceeding three or four inches in length.

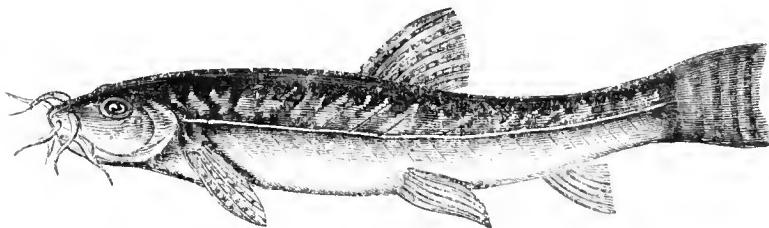


GUDGLON.

The Gudgeon (*Gobio fluviátilis*), distinguished by his brown body spotted with black, and by a

barbule or tendril at each corner of its mouth, will live a long time in captivity, but is very shy, preferring rather to hide among the weeds than to sport in the clear water, and rarely coming out from its retirement except when food is in the way, which, however, it seems to swallow more as a duty than from appetite. It is amusing, however, from its surly expression of countenance.

The Loach or Beardie (*Cobitis barbátula*).—A few sweeps with the shrimping-net, deep down among the gravel of any clear running stream, will probably bring to light a few loach. These

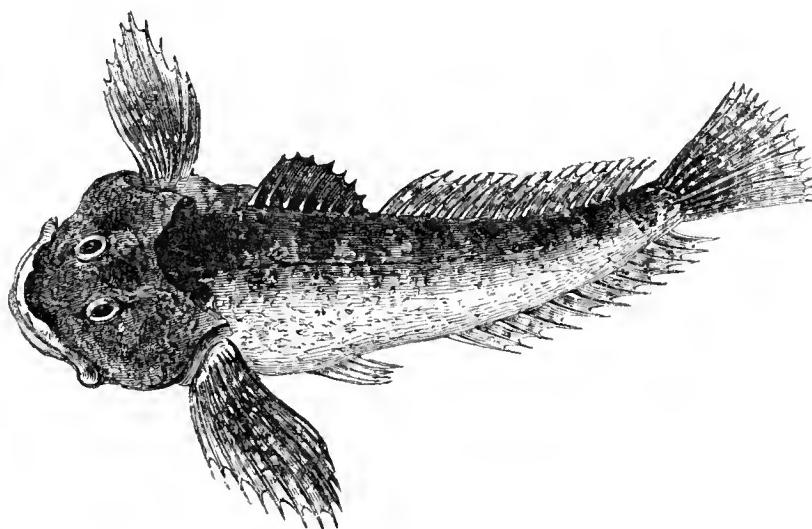


LOACH.

fish may at once be distinguished by their long slug-like shape, their colour mottled like that of a toad, and their beard of six barbules. In their native haunts they are very active; and when first placed in the aquarium they swim about with great rapidity. As far, however, as my experience goes, they are very difficult to keep alive, for after a few days I have invariably found their energy to subside; they then burrow amidst the gravel, and will only move when disturbed; and in the course of a fortnight at the outside, the mucous sub-

stance in which they are at all times enveloped increases in quantity, forming a most unpleasant winding-sheet, which, if not speedily removed with the dead body it contains, infects the whole aquarium. I should add that the loach is said by some to do well in captivity. I have been invariably unsuccessful, but have not much regretted my failure, as the form of the fish is repulsive rather than attractive.

The Miller's Thumb or Bull-head (*Cottus Gobio*), without being repulsive, is positively ugly, and on

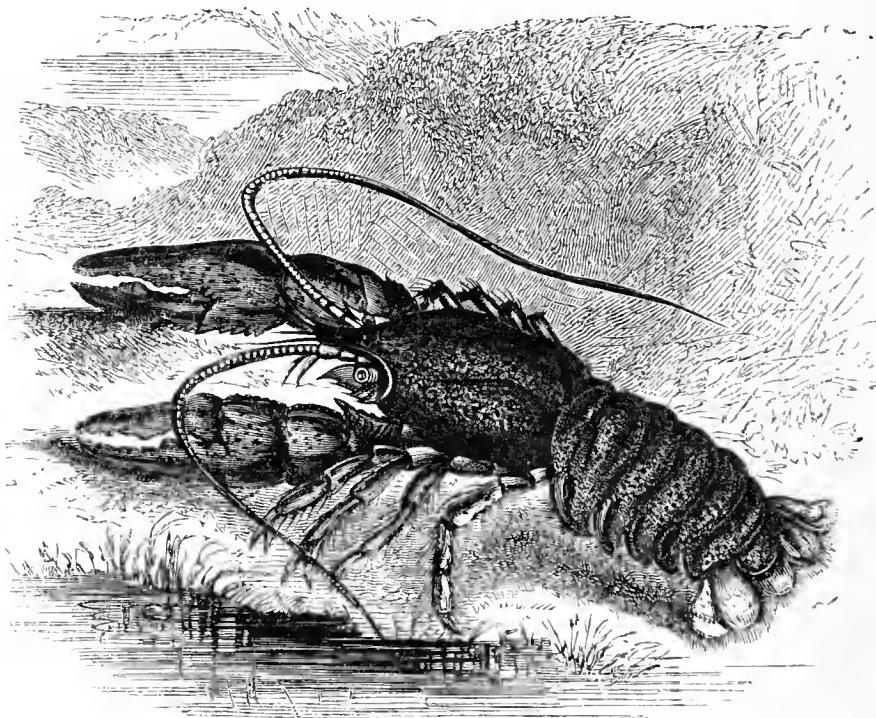


FULL-HEAD.

that account, perhaps, will find its advocates. It may be distinguished at once from all other freshwater fish by its disproportionately large flattened head. I have frequently caught it in the same net with the loach, which it resembles in habits ; but

I have never succeeded in keeping it alive for any length of time.

Astacus fluviátilis (the River Crayfish) is not a fish at all, but a crustaceous animal* resembling a lobster. It is found among the gravel and weeds of clear running streams; and if placed in the bait-can along with small fish, will most pro-



RIVER CRAYFISH.

bably make a hearty meal on one of them before it reaches your dwelling, but will not otherwise repay you for your trouble in catching it. In the aquarium it seems to thrive for a few days, crawling about among the weeds, and forming a

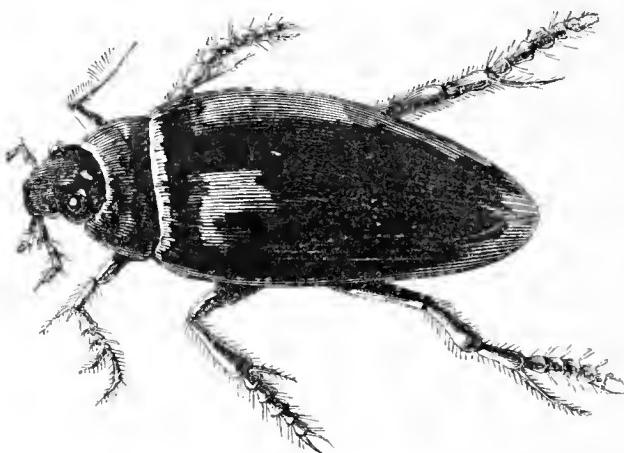
* In French *écrevisse*, corrupted into *crayfish*.

very pleasing variety in the collection ; but, as far as my experience goes, terminating its inactive life in the course of a week or two. Mr. Bell mentions an instance in which one was kept alive for about two years in a glass pan, "in water not more than an inch and a half deep ; previous experiments having shown that in deeper water, probably for want of sufficient aëration, the animal would not live long."

I have omitted to mention the Gold Carp (*Cyprinus auratus*), as being too well known to require any description.

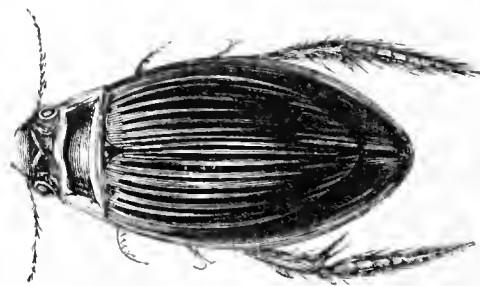
Though, in all probability, most aquatic insects would thrive in a well-managed aquarium, the number which may be introduced with safety into one which contains fish is small. Either the ravenous fish will destroy the insects, or the predacious insects will make the fish their prey ; or, if both be equally warlike in their temperament, they will strive for the mastery, and the weaker furnish the victor with a meal. Among the few which may be associated with fish, is the large black beetle called *Hydróphilus piceus* ; this, though exceeding all other British aquatic insects in size, and very boisterous in its movements, is not found to molest fish, and is too strongly mailed to be injured by them. It is of an olive-black hue above, with a purplish or greenish tinge at

the edges of the wing-cases, deep black everywhere else, except that the antennæ are reddish. It is found in ponds, especially in the neighbourhood of London, but, in all probability, is generally diffused.



HYDROPHILUS PICEUS.

Several species of *Dytiscus* inhabit the ponds and rivers of England, and approach the last in size. These, however, are far from trustworthy. The most frequent species (*D. marginalis*) will de-

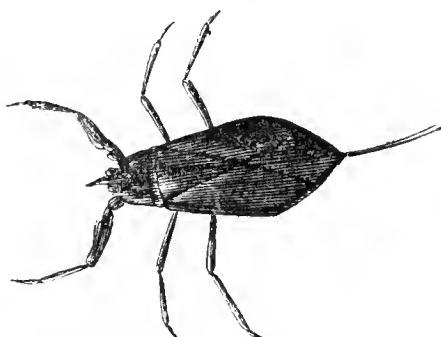


DYTISCUS MARGINALIS.

populate an aquarium in a short time, attacking indifferently any animal that it can make its prey.

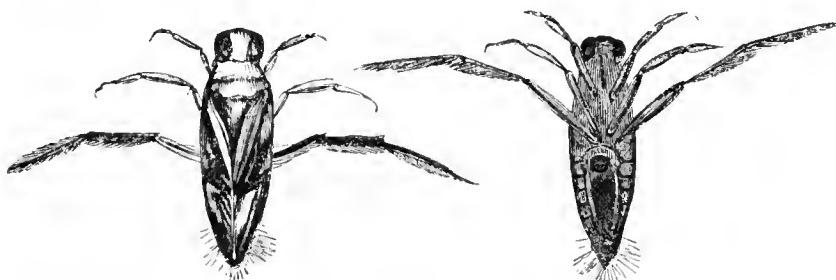
The larvæ of this species are frequently brought to shore in the shrimping-net, and are no less destructive than the perfect insect.

The Water-Scorpion is a very unpleasant-looking animal, resembling a tick, and belonging, in fact, to the same order of insects. It may be known by its thin flat body, having at one end a



WATER-SCORPION.

forked-tail, at the other a formidable pair of instruments far too like the nippers of a scorpion to be agreeable.



WATER-BOATMEN.

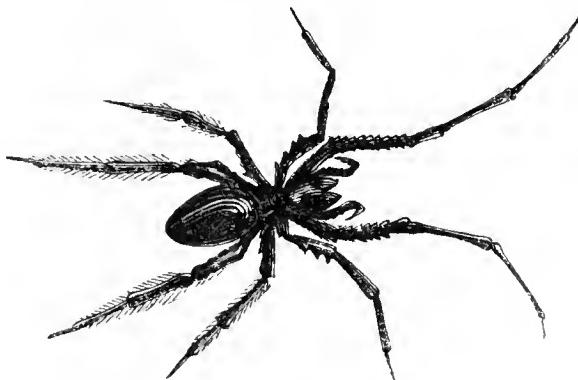
Notonecta glauca (the Water-Boatman) is an active bustling creature, always employed in paddling himself about by starts, with his back down-

wards. His object evidently is to be on the watch for insects which alight on the surface of the water; and a sharp-sighted hunter he is indeed. He commences operations by massacring the whirligig beetles (*Gyrini*) with which the aquarium is stocked; these being demolished, he lies in wait for flies, wasps, spiders, caterpillars, or any other insects you may be pleased to throw in for his amusement. His mode of proceeding is to embrace most lovingly any living thing not too large for his arms to clasp, and simultaneously to descend carrying his prey with him, and burying his terrible beak in its body. Thus the unhappy fly, or whatever it may be, is at once strangled, impaled, and drowned.

All these insects, when submersed, seem to be encased, either wholly or in part, in a mantle of quicksilver; and consequently their appearance is far more brilliant in the water than out. This semblance is owing to some property residing on the surface of their bodies to repel water; and that which looks like quicksilver is a film of air which they have carried down with them, perhaps for respiration, while submersed. Consequently when they rise to the surface, and climb on the leaves of some aquatic, the body is found to be perfectly dry.

A species of Spider (*Argyronéta aquática*) possesses this property to a surprising degree. Not

only does it remain dry when submersed, but makes occasional journeys to the surface, and contrives to enclose between the water and its body a globule of air, which it carries down to the bottom: when among the stems of aquatics, it constructs its balloon-like nest. This amusing

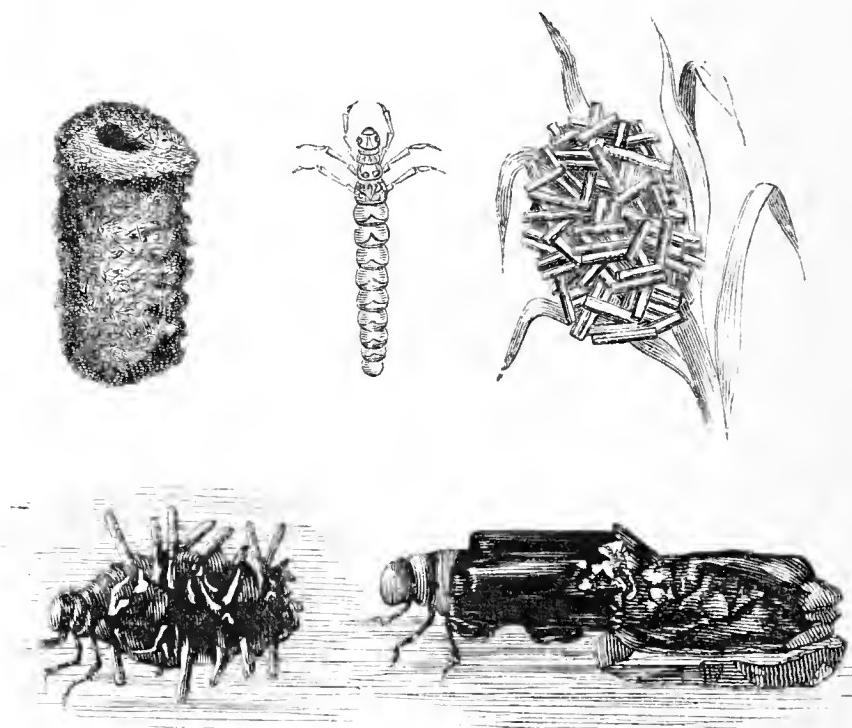


WATER SPIDER.

little animal, which is common in the ponds about London, and probably elsewhere, deserves a vessel to itself out of reach of impudent sticklebacks and voracious beetles. Into the same vessel with it should be thrown a plant of Aquatic Grass (*Glyceria fluitans*) (see p. 49), or something of the same character. Among the roots of this it will nestle, and crawl up and down by its stems; for, although a good swimmer, it is not constituted for perpetual submersion.

We must not forget the Caddis-worm, the larva of several species of four-winged fly, *Phryganea*. These are to be found in abundance, at the bottom of running water, encased in tubes of gravel, small

shells, &c., or at the bottom of ponds, or creeping about upon the weeds, in houses made with particles of wood, the stems of aquatic plants, &c. In an aquarium, they frequently repair their



CADDIS-WORMS.

dwellings with particles cut from the silvery floating roots of water crowfoot, suggesting the idea of a cat peeping out of a muff.

In Mr. Ellis's instructive little volumes, entitled "The Life of an Insect,"* will be found an interesting account of the transformations of the Dragonfly. The larva of this insect inhabits the bottom of ponds and still waters, and may easily be

* Published by the Society for Promoting Christian Knowledge



DRAGON-FLY.

captured with the shrimping-net. It is of forbidding appearance, and most ferocious in its habits, preying with incessant activity on all aquatic insects that happen to come in its way,

and sometimes even on tadpoles and small newts. By keeping a few of these in your aquarium, apart, however, from any other insects which you may wish to preserve, you will have an opportunity of examining at your leisure the wonderful machinery with which it captures its prey, as well as its final transformation into the perfect insect. The aquarium may thus be made instrumental in creating a taste for entomology,—a science which it is scarcely possible to study without at the same time being impressed with the analogy between the transformations of the insect world and the glorious change which will pass upon the redeemed at the general resurrection. Who shall say that the universal law, which subjects insects to changes so striking, was not ordained for the purpose of familiarizing the mind of man not only with the possibility, but the probability of the greatest of the truths which Revelation has confirmed?

I have already mentioned that simple and elegant contrivance for securing the healthy growth of ferns and other plants in confinement, the Wardian case; and before I proceed with my subject, I wish to allude to an error into which many persons have fallen, in supposing it necessary that these miniature gardens should be *perfectly air-tight*. It is enough to say that such a thing is impossible; a perfectly air-tight vessel, except, perhaps, an hermetically sealed tube, being be-

yond the reach of art. Mr. Ward's object in proposing his cases was to provide his plants with moisture, heat, and light, and to exclude soot and noxious salts. So with the aquarium: some persons seem to aim at a condition of animal and vegetable growth in a vessel, the water of which shall never be changed. Now, such a thing, as I have shown, does not exist in nature, which aërates the water of ponds by winds and rains, and that of rivers by currents also. Our object, then, should be to imitate, not to outdo, nature. If our artificial lake is of necessity removed from the influences of the breeze, the shower, and the cascade, we must endeavour to discover some sufficient substitute. The most obvious method of imitating the action of the wind is to introduce the nozzle of a pair of bellows into the water, and to blow lustily. I have found a garden-syringe very effective for this purpose, taking care to draw up the piston with the rose of the engine out of the water. But on no account must you blow into the water by a tube from the mouth, as the air which comes from the lungs, being charged with carbonic acid gas, will tend to vitiate rather than purify the water. Rain may be efficiently represented by a shower of fresh water thrown into the vessel from a considerable height through the rose of a common garden watering-pot. I have, however, adopted a simple contrivance,

which combines the advantages of falling water and a running stream. Before I explain what this is, I must, for the benefit of my younger readers, briefly describe the nature and operation of the *siphon*, a simple instrument, but one which it is impossible to understand without a previous acquaintance with a few leading facts in natural philosophy, with which, if any of my readers are familiar, they can at once, knowing what I am about to say, pass on to the next paragraph.

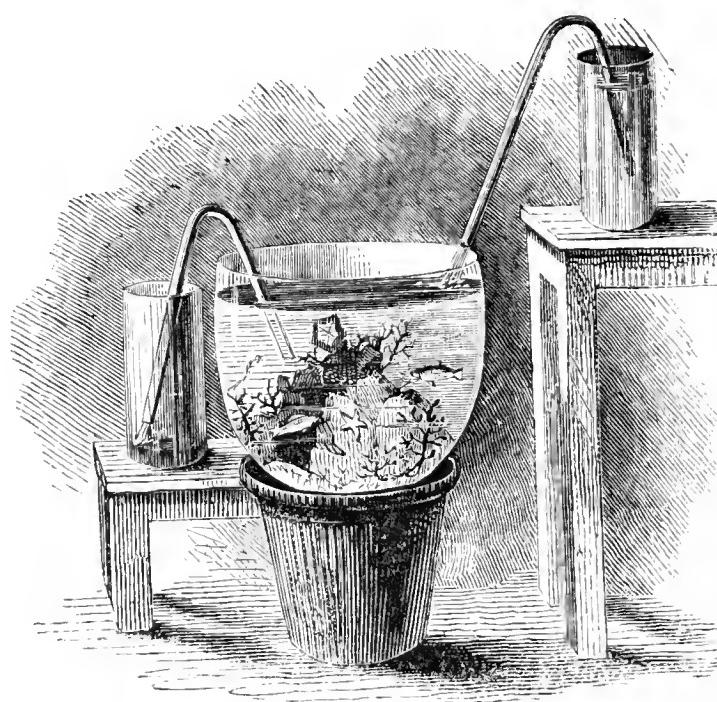
The atmosphere which envelopes the earth is known to press on all objects on the earth's surface with a variable weight, averaging at the level of the sea fifteen pounds on every square inch. On every square inch, then, of water in a pond or in an aquarium, there is a heavy pressure. Now, water is an elastic fluid ; so that if a greater weight than that of the atmosphere be laid on it at any one part, it will be pressed up, or will rise everywhere else. This may be familiarly instanced by placing on it a mass of any substance,—a rod of iron, a ruler, or the hand ; the water will rise in the vessel everywhere except where the additional weight is laid on it. In like manner, if the weight of the air be removed from any part, the water will be forced up by the atmospheric weight which still continues to press on the exposed part. If, for example, I dip a hollow straw into the water, and exhaust the air contained in it, the water will

be forced into my mouth, not by any power of suction residing in my tongue, but by the atmospheric pressure on the water outside the tube. And if, instead of a straw, I exhaust the air from a curved tube, provided that I keep the end of the tube which I hold in my mouth below the level of the water in the vessel, the water will continue to flow after I have withdrawn my mouth, as long, in fact, as the inner end of the tube remains immersed. If now I place under the outer end of the tube or *syphon* an empty vessel, the water will continue to flow until the water-line in the second vessel is on a level with that of the first.

Having premised these few remarks, I will proceed to describe a cheap, simple, and efficient apparatus for sending a running stream through an aquarium,—a stream that may be set to work in five minutes, that shall run for half an hour, or any other definite time, and shall finally stop of itself, without chance of failure, and without the possibility of overflow.

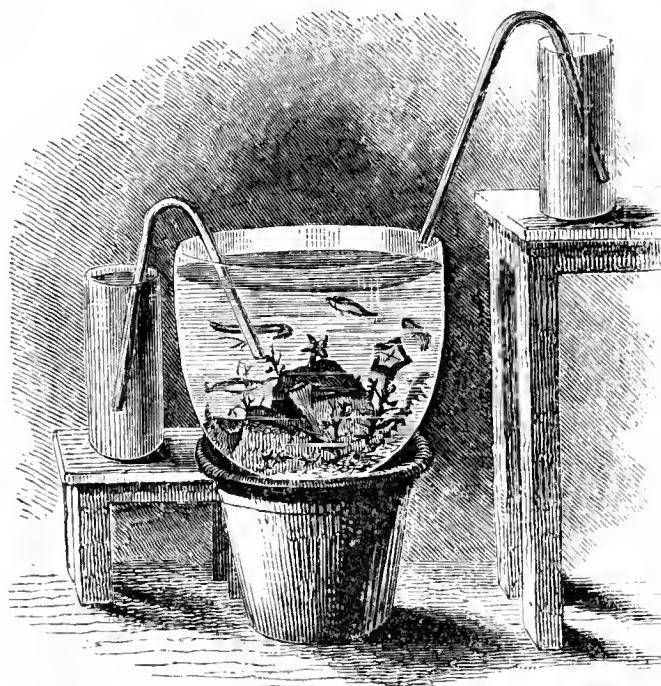
Procure a few feet of gutta-percha tubing, of the smallest size made, which is sold at two-pence a foot. Take about two feet of this, place it in warm water, and, while warm, bend it into the shape of a capital U, but with one arm longer than the other. With a foot and a half of the same tubing make another syphon. Now place

near the aquarium, and raised as much above it as you conveniently can, a vessel of pure water, no matter what size, but the larger the better. Place the short arm of the first syphon into this vessel, exhaust the long arm by sucking out the air, and



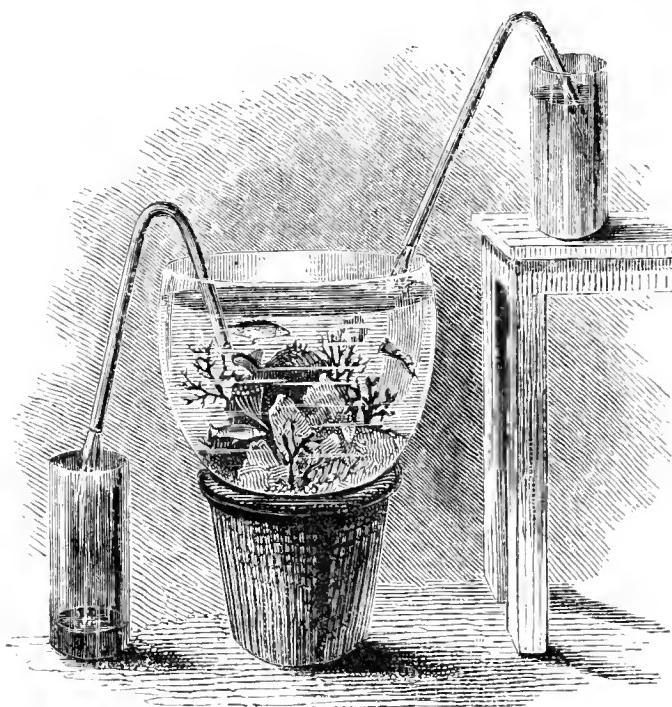
the water will immediately follow, falling into the aquarium, and bringing air with it. Have ready another vessel, *empty*, of the same size as the full one, and set the second syphon at work in the same way as the first; but this must have its shorter arm in the aquarium, the other in the empty vessel. Now elevate the empty vessel, and fix it so that its upper edge shall be a little above the level of the water in the aquarium. Both

syphons will continue to play until the upper vessel is emptied of its contents, and the lower one is full, or rather until the water has risen to a level with the water-line in the aquarium.



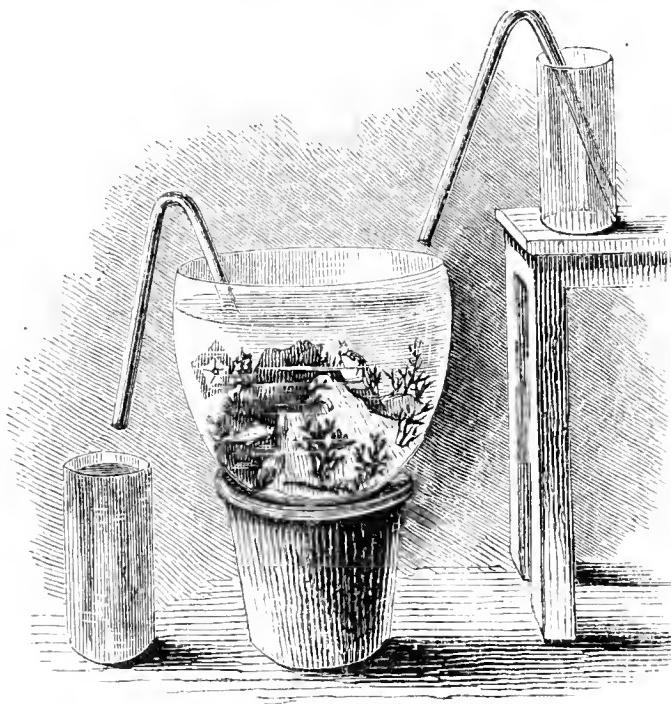
If this operation be attended with any difficulty, the plan may be managed as follows. Let the second siphon have one arm so short that, when rested on the rim of the aquarium, it will barely touch the water; and let the empty vessel rest anywhere below, the full vessel standing as before. Set the siphon from this to work first, but let it play for a minute or two; then exhaust the second siphon, and leave them as before. When the water in the higher vessel is all drawn off, the first siphon will cease running, but the second

will continue to play until the contents of the aquarium are reduced to their original level. The second method will, perhaps, be found the most convenient, it being immaterial at what elevation



the empty can is placed ; and if the fresh water is of a lower temperature than that in the aquarium, which most probably will be the case, the amount of refreshment imparted will also be greater ; for this reason : when cold water (unless near the freezing-point) is poured into water of a higher temperature, it descends ; consequently, the short-armed siphon will feed itself from the surface, or stale water, whereas, by the first method, a portion of the cold fresh water which has descended will be carried off at once.

The only objection that I can see to this apparatus is, that it is not very agreeable to draw into the mouth water which is to be discarded on account of its being stale or tainted. After a little practice, however, you will be able to set the siphon at work by one strong effort of the lips,



and to withdraw your mouth before the water reaches it. But if this method, too, be objectionable, fill the siphon with water in any way ; place the finger on the orifice of the longer arm, and the whole may be removed without spilling a drop, —the reason being, that the weight of the atmosphere presses equally in all directions, upwards against the short arm of a siphon, as well as downwards on water in a vessel.

By these simple means you may give your pets a refreshing shower, and a change of air as well as of water whenever you please. It will be necessary to do it more frequently in summer than in winter ; and as it may be found desirable to renew all the water, a larger syphon should be provided. For this purpose, a foot and a half of tubing, at threepence a foot, will answer very well. You should also be provided with a small net, three or four inches across, with which to catch the fish and insects, and remove them to another vessel. A hoop of copper wire, with a bag of muslin stretched across it, and attached to a stick long enough to reach the bottom of the aquarium, will be found convenient for removing any decaying vegetable matter, unconsumed food, and—sad it is, yet necessary to anticipate such a thing—dead fish. These last should be removed immediately, as the gases they evolve during decomposition will not only render the water offensive, but seriously endanger the welfare of the others. If a fish at any time shows symptoms of discomfort, by swimming lazily at the surface, or turning over on its side, remove it immediately to another vessel, and pour fresh water on it, when it will most probably recover, and that, too, without disturbing or altering the position of the plants.

But there is another tribe of organized beings whose services we must enlist, in order to render

our exhibition unexceptionable. We have provided, you will recollect, growing plants to consume the carbonic acid exhaled by the animals, and living animals to respire the oxygen evolved by the plants ; but we have yet to make further provision. Whenever water is allowed to stand, in warm weather, where it is subject to the action of light, it speedily begins to teem with myriads of minute forms of animal and vegetable life ; and these are propagated with such rapidity that, unless some counteracting influence be provided, the water will be robbed of its transparency, and the vessel which holds it become lined with a green coating.

The undue increase of these minute animals will be prevented by the small fish which are thus furnished with food. Not so the vegetables ; their excessive growth is indeed, in some measure, kept down by the fish (especially Bleak, small Dace, &c.), but not sufficiently ; we must, therefore, have recourse to other measures. We may adopt the purely mechanical plan of cleansing the sides of the aquarium with a sponge fastened to a stick ; and to this we shall, perhaps, find it desirable to resort under any circumstances. But by transporting *all* the contents of a little pool to an aquarium, we shall advance one step further in our imitation of nature (which uses no such clumsy contrivances as sponges or wash-

leathers), and have the advantage of watching a troop of her workmen engaged in their occupation, that, namely, of eating. These are the Molluscs,—soft animals, destitute of skeleton and vertebral column, but often furnished with a horny or stony shell, consisting of one, two, or more pieces. Of these, some species live on the land, such as the slug and snail; others, in the sea, as the periwinkle and cockle; and others, in fresh water. With these last only we have to do; and we propose to introduce them into our aquarium, that they may act as scavengers, eating decayed vegetable substance, and consuming the tender growth of confervæ on the sides of the vessel.

They are to be found in all ponds and slowly-running waters, either floating on the surface, clinging to the submersed plants and those growing on the edge, or buried in the mud.

Planorbis corneus, a disk-shaped shell, with the inner spires sunk below the level of the outer ones,



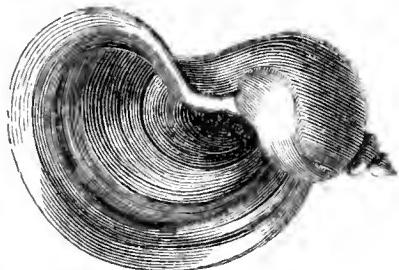
PLANORBIS CORNEUS.

found in stagnant ponds, but not universal, is a very useful species as a scavenger, and is also orna-

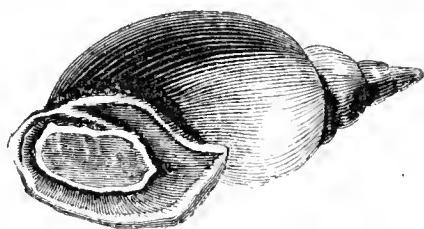
mental in a collection from its fine rich brown colour.

Planorbis carinatus is a smaller species, distinguished by having the outer coil of its shell keeled. It is very common in ponds, and may be caught in great numbers wherever there is the greatest quantity of decaying vegetable substance floating.

Limnæus auricularius, a turbinated or top-shaped shell, of very delicate substance, and, when deprived of its inhabitant, appearing of the consistence and colour of horn, is very common on the reedy banks



LIMNÆUS AURICULARIUS.



LIMNÆUS PALUSTRIS.

of ponds and rivers. It may be distinguished by the very large size of the aperture in comparison with the spire of the shell. *L. palustris*, distinguished by its elongated spire, is its common companion.

The above are oviparous, and their spawn is greedily devoured by fish, newts, and other carnivorous animals.

Paludina vivipara is furnished with a stouter (turbinate) shell than any of the preceding, and

differs from them in several respects. Its orifice is furnished with a horny *operculum*, or lid, like that found in the periwinkle; it is marked by three dark bands, parallel with the spires, and, as its trivial name indicates, it is viviparous, the young animals being produced perfect even to their shells. It is often found thickly covered with



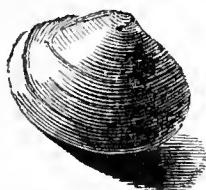
PALUDINA VIVIPARA, WITH ITS OPERCULUM.

green confervæ, on which kind of vegetation it mainly feeds. This and the two species of *Planorbis* are perhaps among the best that we can introduce into an aquarium.

Besides the above snail-like animals (*Gasteropodes*), which will repay our care by their services, there are several others (*Acephales*), belonging to the same class of molluscs with the mussel and cockle, which are worthy of being introduced for the sake of watching their habits. These are, *Anodon cygneus* and *Unio pictorum*, large mussel-like shells, found among the mud and sand of running streams. These may be distinguished at once from all other fresh-water shells by their

superior size, and the first may be further distinguished from the second by its having no tooth in the hinge, but merely a ligament occupying its entire length.

Cyclas cornea is a very pretty little bivalve shell, of the size of the figure, and, in colour, of a



CYCLAS CORNEA.

dull purple. It is abundant among the mud of stagnant pools, and is very generally diffused. In an aquarium it is a most interesting object, being furnished with two pellucid tubes, called *siphons*, which it protrudes from its partially-opened shell, and employs in the process of respiration and digestion. It has also the power of putting out a membrane termed a *foot*, with which it is enabled to alter its position, and even to climb a short distance up the side of a vessel or stalk of a plant. Though perfectly harmless, in intention at least, the little creature has the power of making a formidable defence against aggression. I kept, a short time since, in a glass jar two specimens of the ravenous beetle described above, *Dytiscus marginalis*, together with a few Cyclades. One morning my attention was attracted by the strange movements of one of the

beetles, who was performing his evolutions through the water, having a *Cyclas* attached to his front leg, so that wherever the one chose to go, the other was compelled to accompany him. Next day the same forced companionship continued, but on the third day the partnership was dissolved by the death of the aggressor. A few days afterwards the second beetle was caught in the same manner, and ended his life in a similar way. I could only account for the incident by supposing that the beetle, seeing the protruded siphons of the *Cyclas*, resolved on making a booty, but not observing the trap provided in the partially open shell, "put his foot in it;" the *Cyclas*, however, not approving of this step, and resenting the trespass, closed its shell as a defensive measure; but instead of shutting out the aggressor, shut him in, and kept him a prisoner as long as violence was possible, that is, as long as the beetle lived. When, however, the latter, either worried to death, or drowned by the unusual mooring "for'ard," as the sailors say, ceased its efforts to escape, the *Cyclas*, finding itself unmolested again, began to breathe through its siphons, and the vanquished enemy floated to the surface a dead *Dytiscus*.

I should observe, that several of these molluscs are as sensitive of cold as fish; and the same may be said of many of the insects. The vessel in which they are contained should, therefore, be



COMBINED AQUARIUM AND WARDIAN CASE

covered with a cloth in frosty weather, to prevent radiation of heat. The *Lymnaeus* is sometimes erratic in his habits, and the beetles are sometimes disposed to take a nocturnal flight. The vessels in which they are contained should, therefore, be provided with a covering of perforated zinc, glass, or muslin, to prevent such escapes.

The coloured plate represents the combination of a Wardian Case with a fresh-water Aquarium, invented by Mr. H. Baines, Sub-Curator of the Yorkshire Philosophical Society's Museum. For the management of this he gives the following instructions : — The tank which contains the water in which are the aquatic plants, fishes, molluscs, and insects, is about twelve inches in diameter, and about nine inches deep; near the top in the inside is a flange with a groove, into which runs the condensed water from the bell-glass, which forms the Wardian Case for the ferns, lycopods, &c.; from this groove it descends to the tank below. Into the centre of this vessel I put the glass pedestal. I then cover the bottom with about two and a half inches of fresh but not very rich soil, in which I plant my aquatics : I use for this purpose *Vallisneria spiralis*, *Aponogeton distachyon*, *Nymphaea odorata minor*, and *N. macrantha*. On the soil I put one inch of well-washed flints or sea gravel, which prevents the insects or molluscs from making the water foul.

I then introduce the water through a fine rose to about four or five inches deep, into which I put gold-fish (small) or sticklebacks, or any other small fish; molluscs, *Succinea putris*, *Planorbis corneus*, *carinatus* and *marginalis*, *Cyclas rivicola* and *cornea*; insects, any species of *Colymbetes*, *Hygrotes*, *Hydaticus*, *Gyrinus*, and several other aquatic genera: care must be taken not to introduce any of the large carnivorous larvæ. I then prepare for introducing the plants proper for a small Wardian Case—I put the soil into a blue glass dish, with a rim at the bottom to keep it steady on the pedestal; this dish is one and a half inch deep by seven in diameter, the soil is raised in the centre about two inches; in this I plant the tallest ferns or lycopods, and the smaller round the edge of the dish. The ferns I plant are *Adiantum Capillus Veneris*, *Lastreä dilatata Schofieldi*, a beautiful small Yorkshire variety; *Asplenium viride* and *Trichomanes*; *Asplenium fontanum*, &c.; Lycopods, *Willdenovi*, *umbrosum*, *stoloniferum*, *mutable*, *densum*, and *lepidophyllum*. When planted I cover the soil, in imitation of rockwork, with agates and pebbles of any sort. I then give the whole a good watering before placing the dish on the pedestal; the whole is then covered with the bell-glass. One before me at the present time has been standing in a window eight months; the water has never

been changed, or any addition made, except a small quantity once given to the ferns, &c. in the dish. Should the water become green in the summer, a piece of gutta-percha pipe, with a small rose at the end, will draw off the water, which may be replaced. The bell-glass may likewise be removed with benefit to the plants, and a sprinkling of water given them.

I have not as yet given any hints for the feeding of the various animals we propose to take under our protection. Fish, as every angler knows too well, are in their native haunts proverbially capricious in their appetites, preferring sometimes to breakfast, dine, and sup on different kinds of food ; to-day displaying a most voracious appetite, to-morrow refusing the most tempting bait. The same fastidiousness is observable in the aquarium. I have found, however, that sticklebacks rarely resist the temptation of making a meal on aphides (the little green flies, or blight of roses, and other plants) ; these may either be sprinkled on the surface of the water, or an infested sprig of any plant may be immersed in the water, and it will very soon be cleared. Bleak, if permitted, will join them in partaking of the same food. Carp will sometimes eat crumbs of bread with avidity, at other times nothing will tempt them to make a meal. Minnows and gudgeons are equally capricious ; but the former will sometimes eat paste

made of flour and water (which, by the way, is preferable to bread both for them and carp), and neither of them, if hungry, can resist a small red worm, or a particle of lean meat. Fat will not do, as it is too light to sink ; and these fish, if in health, rarely, if ever, come to the surface in quest of food. Large worms must on account be thrown in ; and the greatest care must be taken to remove every scrap of animal substance which the fish do not consume, or corruption will soon extend throughout the whole of the aquarium. In winter, as we all know, the activity of vegetable life in the earth is relaxed ; the sap of trees ceases to flow, leaves and flowers, to expand : the same inertia extends to a considerable portion of the animal world. The caterpillar lays aside its voracity, and sleeps in a chrysalis ; the busy fly creeps into a corner where the crafty spider has ceased to spread its snares ; the ever-hungry snail glues itself fast in some safe retreat, where it discards all the functions of life save that of breathing ; and some even among the warm-blooded animals, as the dormouse and bat, simulate a temporary death, neither moving nor eating. We must not, then, be surprised if in our little watery world analogous effects are produced. The growth of congeræ is arrested by cold, and the molluscs lose the desire of eating them ; animalcules are no longer produced, and the insects to

which they afforded food bury themselves in the mud ; the smaller fish, their ordinary summer food being thus placed out of their reach, lose all appetite for food retaining, however, their activity, or they would fall an easy prey to the ravenous pike and perch ; these being the only fish which afford sport to the angler in winter ; and they retain their ravenous hunger through this season, because the smaller fish, their ordinary food, do not hibernate in concealment.

Thus, in conclusion, do we see that our toy, the aquarium may, if properly referred to, become to us a page of the book of God's servant, Nature, exhorting us to learn more of Him in His written book, Revelation ; or it may be to us as a prolific garden to which we may, at our will, resort for recreation and, while we satisfy the eye, may strengthen our faith by "sucking divinity from the flowers of nature."

I N D E X.

- Acephales, 122.
Adiantum, 79.
aëration of water, 110.
Anacharis, 51.
Anagallis, 67.
animal life, balance of vegetable and, 28.
Anodon, 122.
Aphides, food of small fish, 127.
AQUARIUM, meaning of the word, 1; sense in which the word is now used, 2; why valuable in towns, 3; useful as an educational instrument, 7; of what material and shape, 10; how to prepare, 13; to stock with plants, 13; to fill with water, 22; aëration of, 110; temperature, 32; effect of frost on, 33; variety of plants which may be employed, 35; instruments necessary, 36; aquatic plants for, 37; bog-plants, 63; to stock with fish, 82; and beetles, 104; to change water, 111; to keep down confervæ, 119; Molluses, 120; combined with Wardian case, 125; to feed animals in, 127.
Argyroneta, 106.
Astacus, 103.
atmosphere, constitution of, 25.
atmospheric pressure, 112.
Awlwort, 72.
balance of animal and vegetable life, 25.
Bartramia, 20.
Batrychospermum, 16.
Beardie, 100.
Beetles, Water, 104.
Bell-flower, 66.
berlin-wool, use of, in aquarium, 62, 78.
Bladder-wort, 45.
Bleak, 98.
Boatman, Water, 105.
Bog Pimpernel, 67.
bog-plants, 63.
bread, food for fishes, 127.
Bull-head, 101.
Bulrush, 73.
Butterwort, 65.
Caddis-worm, 108.
Callitriche, 57.
Campanula, 66.
Capillus Veneris, 79.
carbonic acid in atmosphere, 25; how formed, 26; essential to vegetable growth, 28; in spring water, 31.
cells of Vallisneria, 53.
Centunculus, 69.
Ceratophyllum, 43.
Chaff-weed, 68.
Chara, 54.
Chub, 99.
Cobitis, 100.
cold, excessive, to be avoided, 32.
Conferva fit for an aquarium, 16.
Cornish money-wort, 67.
Cottus, 101.
Crayfish, 102.
Crowfoot, Water, 39.
——— Ivy-leaved, 39.
Crucian Carp, 87.
Cyclas, 123.
Cyprinus, 87, 89, 103.
Dace, 99.
dealers in stock for an aquarium, 5, 36.
Dragon-fly, 109.
Drosera, 62.
Duckweed, 58.
Dytiscus, 104; killed by mollusc, 125.
Elatine, 71.
Fern, Filmy, 79.

- Fern, Maiden-hair, 79.
fish, abundance of, 82.
Flax-seed, 69.
Floating Meadow-grass, 49, 107.
Fontinalis, 18, 19.
food of animals in aquarium, 127.
fresh-water shells, 120.
Frogbit, 44.
Frogs, spawn of, 83.
frost in ponds, 32; in an aquarium, 33.

Gasteropodes, 122.
Gasterosteus, 91.
gills in fish, use of, 29.
Glyceria, 49, 107.
Gobio, 101.
Gold-fish, 103; tenacity of life in, 32.
Grass, floating, 49, 107.
gravel for an aquarium, 14.
Gudgeon, 99.
gutta-percha, a good material for siphons, 113.

Hepaticæ, 77.
Hookeria, 21.
Hornwort, 43.
Hottonia, 46.
Hydrocharis, 44.
Hydrocotyle, 74.
Hydrophilus, 104.
Hymenophyllum, 79.
Hypnum, 17.

Illecebrum, 56.
insects in an aquarium, 103.
iron, water impregnated with, unfit for an aquarium, 22.
Ivy-leaved Bell-flower, 66.
— Crowfoot, 40.

Jungermannia, 78.

Knot-grass, 56.

Lemma, 58.
Leuciscus, 108.
light, effect of, on growing vegetables, 13, 24.
lime, water impregnated with, unfit for an aquarium, 22.
Limnæus, 121.
Lisso-triton, 86.
Liverworts, 77.
Loach, 100.
Loosestrife, 75.
Lycopodium, 79.
Lysimachia, 75.

Maiden-hair fern, 79.
Marsh-pennywort, 74.
Milfoil, 43.
Miller's-thumb, 101.
Mnium, 22, 77.
molluscs, 120.
Money-wort, 75.
— Cornish, 67.
Montia, 71.
Morsus-ranæ, 44.
Moss, aquatic, 18, 21, 22, 76.
Myriophyllum, 43.

Natural History, a fit study for the young, 8.
Newts, 86.
Nitella, 55.
Nitrogen gas, in atmosphere, proportion of, 25; use of, 26.
Notonecta, 105.

Oxygen gas in atmosphere, proportion of, 25; globules of, 24; essential to animal life, 26; to restore to water, 111.

Paludina, 121.
paste for fish, 127.
pearls, artificial, 99.
Penny-wort, 75.
Perca, 96.
Perch, 97.
Phryganea, 107.
Pimpernel, 67.
Pinguiscula, 64.
Planorbis, 121.
plants, why necessary in an aquarium, 24; what may be employed, 35, 62.
Poa, 49, 107.
ponds, frost in, 33; fish in, 82, 87.
Potamogeton, 41.
pressure of atmosphere, 112.
Prussian Carp, 87; tenacity of life in, 89.

Radiola, 69.
rain in aerating water, use of, 31.
Ranunculus, 39, 40.
Red-eye, 99.
Riccia, 78.
Roach, 99.

Scirpus, 73.
Scorpion, Water, 105.
shell-fish, 120.

- Sibthorpia, 67.
 spawn of frogs, 83.
 Spider, Water, 107.
 spring-water, 22.
 stagnant-water, how aërated, 31.
 Starwort, Water, 57.
 Stickleback, 91.
 Stratiotes, 49.
 Subularia, 72.
 Sundew, 62.
 syphon, 112.
 Tadpoles, 84.
 temperature of water in aquarium, 32.
 Tench, 89.
 Thyme, Water, 50.
 Tinca, 89.
 Unio, 122.
 Utricularia, 45.
 Vallisneria, 52.
 vegetable life, balance of animal and, 25.
 Villarsia, 48.
 Wardian case, why valuable in great towns, 4—; not air-tight, 110; combined with aquarium, 125.
 warm-blooded animals, why so called, 28.
 water fit for an aquarium, 22; how aërated, 111.
 Water Beetles, 104.
 —— Blinks, 70.
 —— Boatman, 105.
 —— Crowfoot, 37.
 —— Milfoil, 44.
 —— Plantain, 36.
 —— Scorpion, 105.
 —— Soldier, 50.
 —— Spider, 107.
 —— Starwort, 57.
 —— Thyme, 50.
 —— Violet, 47.
 Water-wort, 71.
 Winter, torpor of animals in, 128.

THE END.



